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## Unmanned Systems Sentinel / 14 December 2015

Monterey, California: Naval Postgraduate School

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## **Unmanned Systems Sentinel Summary**

Please keep in mind that in most instances the below summaries are excerpts from the original article. The full articles can be viewed at the accompanying hyper-links. The inclusion of these links does not represent an endorsement of the organization, service, or product. All opinions expressed are those of the respective author or authors and do not represent the official policy or positions of the Naval Postgraduate School, the United States Navy, or any other government entity. Immediately below are this edition's highlights with bookmarks to the respective articles:

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## **NAVY/USMC:**

### **MQ-8C completes Operational Assessment**

The US Navy has successfully completed land-based operational assessment (OA) of the MQ-8C Fire Scout, Northrop Grumman announced on 1 December.

The OA was conducted at Naval Base Ventura County, Point Mugu, in November by the navy's Air Test and Evaluation Squadron VX-1.

According to Northrop Grumman all aircraft systems successfully met VX-1 flight requirements. MQ-8C sensors and systems were tested at different altitudes and ranges to validate operational effectiveness. Integration of an improved ice detector system was also validated with an alert to the test team of icing

during a flight. This system allowed for necessary altitude corrections by descending the helicopter until the indication cleared so that the mission could resume its target detection runs.

Capt Jeff Dodge, Fire Scout program manager, Naval Air Systems Command, said: 'MQ-8C represents a significant capability improvement to the fleet. Testing has shown the system is meeting or exceeding our goals and the completion of this test event represents a major step on the road to fleet introduction.'

Leslie Smith, fire scout program director, Northrop Grumman, added: 'The completion of land-based OA is once again validation of the incredible performance the Fire Scout system is capable of. As demonstrated in the test, Fire Scout's multi-INT capability and endurance, coupled with outstanding reliability are changing the way intelligence, surveillance and reconnaissance systems are measured; we have significantly raised the bar.'

The MQ-8C program is now preparing for milestone C in 2016.

<https://www.shephardmedia.com/news/uv-online/northrop-grumman-us-test-unmanned-helicopter/>

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### **Iowa State University professor helps with underwater unmanned vehicles**

One member of Iowa State's faculty is helping create an innovative and green way to propel underwater unmanned vehicles.

Jonathan Claussen, assistant professor of mechanical engineering, joined Brian Iverson, assistant professor at Brigham Young University, and the U.S. Naval Research Laboratory to create underwater unmanned vehicles that are used for simple tasks such as delivering payloads, lacing sensors and reconnaissance missions for the military.

The current issue is that these vehicles aren't maneuverable with the propellers currently being used. Claussen said the issue with conventional propellers is it is difficult to get the thrust needed for quick burst for tight and accurate maneuvers. There have also been issues of propellers not having enough thrust to get the vehicles into charging stations.

Claussen found that using an old type of fuel to thrust the vehicle like a rocket is a better solution.

The vehicles designed with the chemical green power source in mind are aimed to be cheaper to produce and biodegradable. Once the vehicle outlives its use, it degrades safely in the environment without the need for retrieval.

Iowa State has partnered with Brigham Young's Naval Research Project, NASA and the Department of Defense to complete the underwater unmanned vehicles power source project.

[http://www.iowastatedaily.com/news/academics/article\\_5c8b8c36-997f-11e5-be25-37c3ad231958.html](http://www.iowastatedaily.com/news/academics/article_5c8b8c36-997f-11e5-be25-37c3ad231958.html)

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## **The Navy's \$864 Million Underwater Drones Still Don't Work**

Pentagon test data show 24 major failures since September 2014

Crippled Lockheed drones towed to port seven times this year

The U.S. Navy's new Littoral Combat Ship would be ineffective at hunting for mines because an underwater drone made by Lockheed Martin Corp. that's supposed to find them often fails to work, the Pentagon's weapons-testing office found.

While mine-hunting is intended to be the primary combat mission of the ship, the drones required to detect underwater explosive devices from a safe distance have failed 24 times since September 2014, according to Navy test data provided to the Defense Department's Office of Operational Test & Evaluation.

Most recently, the drones failed 14 times over 300 hours in a five-month round of preliminary trials at sea that ended Aug. 30, according to the data. Crippled drones were towed to port seven times, and the intense combat testing required for increased purchases has been delayed. The Navy plans to spend \$864 million buying 54 drones from Lockheed, the biggest U.S. contractor.

Frank Kendall, the under secretary of defense for acquisition, has scheduled a Jan. 19 review of the drone's reliability woes, the latest setback for the troubled Littoral Combat Ship program. Michael Gilmore, the Pentagon's director of combat testing, prepared a 41-page classified assessment dated Nov. 12 for the review.

### **Lockheed's Response**

Lockheed spokesman Joe Dougherty said in an e-mail that the drone "exceeded or met key performance parameters during a Navy-led development test conducted in early 2015." He said the Remote Minehunting System is "the only system on track for delivery that can fill" an "imminent capability gap."

"We remain confident the RMS is the most mature system to identify and destroy mines," Dougherty said. A Lockheed brochure posted online and dated 2014 says the drone "meets or exceeds all key performance parameters and is available today."

Senator John McCain, chairman of the Senate Armed Services Committee, said in an e-mail Tuesday that the new report "only furthers my concerns about the testing and reliability performance of the Littoral Combat Ship's troubled mine countermeasures capability. "

Previous Questions

In 2014 then-Defense Secretary Chuck Hagel truncated the original plan to buy 52 Littoral Combat Ships, built to operate in shallow coastal waters, citing reservations about the vessel's effectiveness in combat and vulnerability to attack. Later, he approved a Navy proposal to buy 20 modified ships after 2019 with improved armor, sensors and weapons.

The Navy spent \$109 million buying the first eight drones, spare parts and logistics services from Lockheed in 2005. The drone was supposed to complete combat testing and be declared ready for combat by September of this year. Lockheed stands to gain more than \$700 million in orders for the remaining 46 drones. That includes as much as \$400 million in February for the next order of 18 that Kendall will review.

The system's "reliability remains far below what is needed to support" the mine-hunting mission, Rankine-Galloway said. It's unclear whether the drone "will ever achieve its reliability goals" of operating 75 hours between major failures, "but given the history of the program, it may require more design changes than the Navy has been considering," Rankine-Galloway said.

#### Airborne System

Further, the Littoral Combat Ship's separate, airborne-based AN/ASQ-235 mine neutralization system currently can't disable "most of the mines contained in the Navy's own real-world threat scenarios," Rankine-Galloway said. The system, which would be deployed on MH-60S helicopters, is intended to destroy the mines found by the drones.

Since September 2014, the drone has experienced 24 "operational mission failures" blamed on poor workmanship, design deficiencies, wear and tear or training procedures, Kendall was told Nov. 3 in a memo from David C. Brown, his deputy for development testing.

<http://www.bloomberg.com/news/articles/2015-12-08/littoral-combat-ship-can-t-hunt-mines-due-to-unreliable-drone>

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### **Navy to Spend \$4M on Tossable, Versatile Robots**

During the bloody battle for Fallujah in 2004, Marines took heavy casualties clearing the Iraqi city house by house, room by room, never knowing where a deadly ambush might be waiting.

Now there's a small robot capable of reducing that risk. The key advance is durability: It can be tossed from behind cover, around corners, through windows and up onto balconies and still send real-time images.

According to contract listings on [usaspending.gov](http://usaspending.gov), Naval Explosive Ordnance from the Naval Surface Warfare Center bought a few of iRobot Corp.'s 110 FirstLook robots for \$138,790 in 2012. Veterans Affairs in Lebanon, Pa., got some for hazardous material handling a year later for \$45,764.

Now iRobot says the Navy has put together a \$4 million purchase of robots and accessories, which could be heading into action soon. Delivery is scheduled by February.

“iRobot is pleased to provide these state-of-the-art robots to the U.S. Navy as they will help to address a wide variety of missions,” Tom Frost, senior vice president and general manager of iRobot’s Defense & Security business unit, was quoted as saying in a company statement.

“FirstLook is light enough and rugged enough to be thrown through a window or down a flight of stairs, and its capabilities are expandable with the addition of different payloads,” Frost said.

It’s compact – 4 inches tall, 9 inches wide and 10 inches long – and can travel at just over 3 mph and weighs just five pounds, according to iRobot’s website. It has four 360-degree cameras, is waterproof up to several feet, can survive a fall of 15 feet to concrete and rights itself when flipped over. The cost is about \$19,000 to \$20,000 apiece.

FirstLook can be outfitted with a manipulator to interact with its environment and various mission packages for intelligence, surveillance and reconnaissance, explosive ordnance disposal, hazardous chemical detection and day, night and all-weather operations.

“This is an extremely reliable, rugged, robot,” Ryan said. “That’s its most important feature.”

Navy and Defense Department officials declined to provide details on which commands bought the robots or their intended use. A spokesman for iRobot said the purchaser requested anonymity.

Bedford, Mass.-based iRobot has sold more than 5,000 robots since it was founded 25 years ago, Ryan said. They are probably best known for the PackBot, which was a life-saver for explosive ordnance disposal technicians during the Iraq and Afghanistan conflicts.

<http://www.stripes.com/news/navy-to-spend-4m-on-tossable-versatile-robots-1.383920>

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## **The Navy's rising tide of UUVs**

Unmanned aircraft get all the attention nowadays, but it is beneath the waves where robots are making a splash.

From detecting and clearing underwater mines to reconnaissance and mapping the ocean floors, unmanned underwater vehicles (UUVs) are becoming increasingly prominent.

In late October, Secretary of the Navy Ray Mabus announced that a squadron of large displacement unmanned underwater vehicles (LDUUV) will be stood up by 2020.

“These systems are affordable and rapidly deployable worldwide,” Mabus said. “They’ve already been operational and served as critical enablers and game-changers for minehunting missions, such as those that will be conducted aboard the LCS [littoral combat ship].”



While the ocean depths are murky, the attraction of unmanned vehicles for undersea operations is not. Like their robotic counterparts in the air, on land and on the ocean surface, underwater craft are great for dull, dirty and dangerous tasks. They can search for and clear mines while their operators remain safely at a distance, map the ocean floor for monotonous mile after mile, or conduct surveillance of ships and harbors. A 2009 RAND Corp. study lays out a litany of possible UUV uses, including quick strikes from underwater craft quietly positioned close to their targets, anti-submarine warfare and cyber warfare by accessing underwater communications links.

Naval Sea Systems Command (NAVSEA) has several UUV projects underway, according to spokesman Matt Leonard. These include:

- The LDUUV is still under development, but the Navy says it will be considerably larger than 21 inches in diameter, which happens to be the diameter of U.S. submarine torpedo tubes. In addition to the LCS, the LDUUV will be capable of operating from Virginia- and Ohio-class submarines. The intended missions will be more sophisticated than those performed by many current UUVs, including ISR, signals intelligence, anti-submarine warfare, mine countermeasures and strikes on enemy targets. The LDUUV will be long-endurance, reconfigurable and modular, with the ability to operate autonomously in littoral waters. Initial operating capability is scheduled for fiscal 2021, with the Navy planning to acquire 10 vehicles.
- The Knifefish is a big mine-detecting UUV, 22 feet long and weighing 2,200 pounds. Designed to detect bottom, buried and moored mines in cluttered underwater environments, it can be operated from the LCS and other vessels, and each two Knifefish team can be tasked with clandestine Intelligence Preparation of the Operational Environment (IPOE) reconnaissance. Initial operating capability is slated for 2018, with the Navy set to buy 30 systems.
- The MK18 Mod 1 Swordfish is based on the man-portable 7.5-inch diameter Remote Environmental Monitoring Unit System (REMUS) 100 model, which is made by the Woods Hole Oceanographic Institute. The Navy has 27 Mod 1 Swordfish, designed for low-visibility exploration and reconnaissance to support amphibious landings, mine countermeasures detection and hydrographic mapping in the very shallow water zone of 10- to 40-foot depth. The Navy is also developing the MK18 Mod 2 Kingfish, which is slated for operations by the end of fiscal 2016. The Kingfish, which is based on the lightweight 12.75-inch diameter REMUS 600, has greater endurance than the Swordfish and offers an increased area coverage rate through the ATLAS forward-looking sonar. The Navy has 12 Kingfish, rising to 24 by fiscal 2016's end.
- The Littoral Battlespace Sensing (LBS) system is also based on a REMUS vehicle. The LBS-G is a long-endurance glider that is propelled by changes in buoyancy, and guided by wings and tail fins. It is used to collect oceanographic data. The LBS-AUV is a REMUS 600 used for anti-submarine, mine warfare, naval special warfare and persistent IPOE. Space and Naval Warfare Systems Command has ordered three LBS systems for environmental surveys of ocean, coastal and inshore waters.
- The Persistent Littoral Undersea Surveillance (PLUS) system consists of underwater gliders and REMUS 600 to detect and localize targets in support of anti-submarine warfare operations.

“The UUVs perform as autonomous vessels with long underwater dwell times that carry highly capable sensors,” according to NAVSEA’s website. “The sea gliders are smaller autonomous vessels that collect the UUV data, and return to the surface to transmit that data to a shore-based collection and processing station. The PLUS system is designed to easily deploy from any ship with a winch and crane and sufficient storage capacity.”

In addition, sea gliders operated by the Naval Oceanographic Office (NAVOCEANO) have been mapping the depths since 2012.

NAVOCEANO uses Slocum gliders, developed by Teledyne Webb. Each glider is about 5 feet long, and resembles model airplanes. NAVOCEANO also uses a number of Systems Hosting Autonomous Remote Crafts (SHARCs), variants of the Wave Glider from Liquid Robotics Inc.

The gliders, controlled from Stennis Space Center through the U.S. military’s Iridium satellite network, collect data on ocean temperature, salinity, clarity and pressure. The data is used for forecasting oceanographic conditions. Operating at a speed of 0.5 knots, they typically dive to nearly 1000 meters and can operate for up to four months.

“Each glider profile [data collection] costs less than \$100, compared to over \$10,000 for a ship-based profile,” according to a NAVOCEANO fact sheet. “The glider itself costs roughly that of three days of survey ship operations.”

But UUVs are not solely an American preserve. Norway’s Kongsberg offers several models, such as the HUGIN, which can operate at depths of up to 6,500 yards. Then there is Saab’s AUV62-MR mine-reconnaissance UUV, as well as its Double Eagle SAROV mine-detection vehicle, which can operate either under remote control or autonomously.

Navies are just starting to scratch the surface in terms of UUVs.

“The early part of this decade can be viewed as the beginning of a transitional period,” said Jason Stack, program officer for the Ocean Battlespace Sensing Department at the Office of Naval Research. “We now have UUVs that work, work reliably, and are getting affordable enough to buy and field in numbers. Now the emerging technology is focusing on how to employ these systems in increasingly capable and sophisticated ways.”

Stack predicts UUVs will become more automated and autonomous. “A significant trend will be for UUVs to achieve a better ‘understanding’ of their situation and surroundings, be able to have a more rich conversation about this with their human supervisors or counterparts, and to be able to adapt in real-time as appropriate,” he said. “This stands in stark contrast to many of today’s employments that are essentially constituted by blindly following preprogrammed paths to collect data for later analysis by humans.”

Much like the UAV world, where the weaponization of autonomous systems and the development of unmanned combat aircraft have raised concerns about humans in the loop, autonomy is a major issue with underwater craft. Interestingly, Stark speaks of a cycle of trust.

The evolution of UUV technology promises a future of greatly enhanced — and perhaps even faintly disquieting — capabilities.

“Major improvements in UUV capabilities will be realized as UUVs become able to assess their own performance and proficiency in stride — this is something humans do naturally, and machines typically can’t do at all,” Stark said.

If UUVs can assess themselves, then they can adapt themselves to changing undersea conditions.

“This will begin to bring the performance of the machine to a level that many people implicitly expect — the machine may not be perfect the first time it tries a new task or old task in a new environment, but it improves noticeably with every experience,” Stark said.

<http://www.c4isrnet.com/story/military-tech/uas/2015/12/11/navys-rising-tide-uavs/77037336/>

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## **ARMY:**

### **Gray Eagle performs manned-unmanned teaming in South Korea**

The Gray Eagle unmanned aircraft system has performed manned-unmanned teaming with an AH-64 Apache helicopter during exercises in South Korea in August.

The Gray Eagle "streamed video and metadata via a line-of-sight data link directly to a U.S. Army AH-64 Apache helicopter from extended distances," according to a General Atomics news release. "The Apache subsequently was able to re-transmit the imagery to a One System Remote Video Terminal (OSRVT), allowing ground forces to view the video from the helicopter."

Commanders at the tactical operations center were able to receive both live Gray Eagle streaming video and re-transmitted video sent by the Apache. "Once Gray Eagle was airborne, U.S. ground forces passed contact reports and target coordinates to operators in the aircraft's One System Ground Control Station," General Atomics said. "The operators were then able to direct the Gray Eagle's sensors to positively identify and track the targets."

"These flights represents a major milestone for the MQ-1C Gray Eagle as they successfully demonstrated manned-unmanned teaming in South Korea and proved the aircraft's ability to conduct operations in diverse weather conditions that are typical on the Korean Peninsula," said General Atomics president Frank Pace. "They also marked a new company milestone for Gray Eagle with its first mission in South Korean airspace."

<http://www.c4isrnet.com/story/military-tech/uas/2015/12/01/gray-eagle-performs-manned-unmanned-teaming-south-korea/76604074/>

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## **USAF:**

### **Air Force Modernization on the Table**

WASHINGTON: Air Force Chief of Staff Gen. Mark Welsh made clear today that, while his service will make its arguments for modernization programs such as the JSTARS replacement, F-35 and Long Range Strike Bomber, the Defense Secretary and the combatant commanders will make the final decisions.

“One of the ways that we’ll accommodate this \$15 billion or so cut is there will probably be some slowdowns in some modernization’s programs,” Pentagon Comptroller Mike McCord said yesterday at the Center for Strategic and International Studies.

But Welsh’s comments about the “need for dialogue” with Defense Secretary Ash Carter and the Combatant Commanders mark a stark departure from the old budget wars. In days of yore, a military service fought to the death to preserve its budget share and its most important capabilities. Service chiefs often publicly mocked their budget competitors and publicly ignored the Office of Secretary of Defense, the heavyweight in the room.

The Air Force boasted how precision strike would make the Army unnecessary. The Army bleated that no war could be won without “boots on the ground.” The Navy muttered about carriers and submarines, warily watching the other two.

Add the current Defense Department budget situation — there’s a funding gap for the 2017 budget and the Air Force just added an \$85 billion program to the mix — heightens the drama. “There is a lot of debate right now inside the Air Force,” Welsh admitted. On top of that debate, there’s a much higher level set of decisions that must be made. “I think it’ll be much more than an Air Force decision. There will have to be some department prioritization done about what to keep and what to take away,” Welsh told the Atlantic Council audience. Those decisions should be made by Christmas.

The other interesting tidbit from today’s appearance was Welsh’s defense of the current mix of manned and unmanned aircraft in response to a question about buying more expendable aircraft.

“Your assumption that Remotely Piloted Aircraft <http://breakingdefense.com/2015/11/aurora-flight-sciences-ceo-takes-otto-to-task/> (drones) are cheap is a bad assumption. The cost curve looks just like manned aircraft today and it will get worse if we’re not careful,” he said, adding the costs of maintenance and the large number of people required to fly and land drones <http://breakingdefense.com/2015/10/how-to-cut-predator-reaper-uav-crew-in-half-lt-gen-otto/>. He noted the Air Force is buying a mix and should stick with that while we figure out how best to blend drones and manned aircraft and just what roles and what weapons mixes work best.

<http://breakingdefense.com/2015/12/air-force-modernization-on-the-table-csaf-gen-welsh/>

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## **ACC charts path for remote aircrews, units**

JOINT BASE LANGLEY-EUSTIS, Va. (AFNS) -- Air Combat Command officials announced the results of their study into the remotely piloted aircraft (RPA) community in an attempt to normalize operations and ensure long-term mission success.

Initial recommendations from the command's ongoing Culture and Process Improvement Program (CPIP) were derived from nearly 2,500 inputs from Airmen across the RPA community as well as staff analysis and budgetary planning. The result was over 140 tasks the Air Force is undertaking to improve RPA operations. The CPIP initiative supports current and previous efforts to normalize operations and is the first of its kind with this level of collaboration and top-level interest across the Air Force.

Over the years, Air Force leaders have made or pushed for substantial base-level investments in support of RPA Airmen and their families. Earlier this year, an initiative led by the secretary of the Air Force reduced RPA operations from 65 to 60 lines daily, while temporarily managing pilot assignments to stabilize the career field until the remote pilot training pipeline could be expanded. The draft 2016 National Defense Authorization Act includes language that expands the Air Force's bonus authority for remote operators and aligns RPA operator entitlements with those for other rated positions. The service is working a plan to apply that authority.

Moving forward, Gen. Hawk Carlisle, the ACC commander, has directed his staff to develop detailed implementation plans for the following activities:

- Approximately double the number of RPA flying squadrons.
- Create a new wing to normalize organizational and command and control structures relative to other weapon systems.
- Standardize the squadron, group and wing structure.
- Assign RPA units in new locations to potentially include overseas locations.
- Decrease the heavy burden of persistent in garrison combat operations by increasing RPA manning and associated resources by 2,500-3,500 Airmen.
- Define career tracks for officer and enlisted RPA operators and maintainers.
- Study the promotion and professional military education selection rates for RPA officers.
- Study the feasibility of a single specialty code for RPA maintenance personnel.
- Streamline processes to better enable Reserve component forces to support the mission.

"As we strategically analyze the RPA community, we need to take a hard look at our operating locations," Carlisle said. "Expanding our RPA basing to potential sites such as Davis-Monthan (Air Force Base, Arizona), Langley (AFB, Virginia), and a few overseas locations is a discussion we need to entertain

as we stand up a new wing. We would look to take advantage of the synergy between RPA operations and command and control or intelligence processing, exploitation and dissemination nodes."

"RPAs have changed the game on the battlefield with their persistence and ability to both build situational awareness and close the kill chain," Carlisle said. "Ultimately, CPIP is about establishing a coherent, Air Force wide strategic plan that enables us to continue to provide this incredible capability to the joint force by moving the RPA community toward the sustainment model we've established for other Air Force weapon systems."

<http://www.af.mil/News/ArticleDisplay/tabid/223/Article/633740/acc-charts-path-for-remote-aircrews-units.aspx>

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## **NATIONAL AIR SPACE:**

### **Collaborative Unmanned Systems Demonstration**

ROME, N.Y. — Lockheed Martin demonstrated its ability to integrate unmanned aircraft system (UAS) operations into the National Airspace System (NAS) using its prototype UAS Traffic Management (UTM) capabilities, the company said in a Dec. 2 release.

During the demonstration on Nov. 18, the Stalker XE UAS provided data and a precise geolocation to the unmanned K-MAX cargo helicopter, which conducted water drops to extinguish a fire, while the UTM tracked the UAS operations and communicated with Air Traffic Control in real time.

"This demonstration represents the path forward for flying UAS in the NAS using Flight Service-based UTM capabilities to extend the technology and systems that air traffic controllers know and understand," Paul Engola, vice president, Transportation & Financial Solutions, said in the release. "We were able to successfully modify the existing K-MAX and Stalker XE ground control software to connect to the UTM services and conduct the firefighting mission."

For more than 80 years, manned aircraft have supported firefighting missions during daylight hours. Because unmanned K-MAX can fly day and night, in all weather, its insertion into firefighting operations offers the potential to triple the amount of time ground firefighters can receive aerial support.

The Stalker XE UAS worked in tandem with K-MAX to identify hot spots and fire intensity with its electro-optical, infrared camera. Its stable, high definition imaging capabilities enable day and night operations. Powered by a ruggedized solid oxide fuel cell, Stalker XE achieves more than eight hours of flight endurance.

<http://www.seapowermagazine.org/stories/20151202-lockheed-uas-demo.html>

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## **Workhorse Group Obtains Section 333 Exemption from Federal Aviation Administration to Test HorseFly(TM) UAS**

CINCINNATI, Dec. 9, 2015 -- The Federal Aviation Administration (FAA) has granted Workhorse Group Inc. Exemption No. 13564 (Regulatory Docket No. FAA-2015-3055) following the company's petition requesting Section 333 exemption to test its HorseFly™ unmanned aerial system (UAS), stating, in part "in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333.... [T]he UAS operation enabled by this exemption is in the public interest."

The Section 333 Exemption process provides operators who wish to pursue safe and legal entry into the National Air Space a competitive advantage in the UAS marketplace, thus discouraging illegal operations and improving safety. It is anticipated that the use of UAS could result in significant economic benefits, and the FAA Administrator has identified this as a high priority project to address demand for civil operation of UAS for commercial purposes.

This exemption follows the receipt of a Certificate of Authorization to the Ohio/Indiana UAS Center and Test Complex, which allows Workhorse and the University of Cincinnati to continue their joint development of Workhorse Group's HorseFly™ at the Wilmington Air Park in Wilmington, Ohio.

Stephen Burns, CEO of Workhorse Group, said, "The granting of this exemption by the FAA represents a key milestone in our development of the HorseFly UAS. We have already initiated testing HorseFly in conjunction with our partner, the University of Cincinnati, at the Ohio/Indiana UAS Center and Test Complex. We expect to keep our shareholders informed of progress as testing continues."

Workhorse Group is developing HorseFly, an eight-rotor "octocopter," designed to be used in tandem with its EPA-approved electric work trucks. Weighing 15 pounds empty, HorseFly has a payload capacity of 10 pounds; it can achieve a maximum speed of 50 mph and a flight time of 30 minutes. The HorseFly UAS, which is subject to FAA approval for commercial use, is designed to be given a package and a delivery destination by a delivery driver, using a touchscreen interface in the delivery truck. The HorseFly has the ability to launch itself from the roof of the delivery vehicle and ascend to a safe cruising altitude and then navigate to the desired delivery point—say, a house's front stoop—autonomously, using GPS navigation.

<http://globenewswire.com/news-release/2015/12/09/794112/10158200/en/Workhorse-Group-Obtains-Section-333-Exemption-From-Federal-Aviation-Administration-to-Test-HorseFly-TM-UAS.html>

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## **Lockheed Martin: Simple ATC Mods Would Allow Drone Flights**

Relatively simple modifications to existing ATC automation systems would allow controllers to monitor unmanned aircraft and manage potential conflicts with other aircraft in the same airspace, according to

automation provider Lockheed Martin. In a recent firefighting demonstration involving two unmanned aircraft systems (UAS), the company said it proved its ability to monitor a UAS that departs from its planned area of operation.

Lockheed Martin is developing UAS traffic management, or UTM, capabilities using its own research and development funds, and, separately, participating in the NASA-led effort to design a low-altitude UTM system for small drones. While the latter research effort is building a “soup-to-nuts” infrastructure that would safely separate and manage drones flying below 500 feet, “we are more focused on getting operational capabilities deployed into the NAS [national airspace system] right now,” Mike Glasgow, Lockheed Martin Flight Services chief architect, told reporters in a conference call.

The “web-services framework” that Lockheed Martin is developing for UTM is a set of software interfaces that enable a UAS ground station to communicate with the company’s flight services network, a web-based system general aviation pilots can use to file flight plans, study weather and aeronautical briefings and receive in-flight alerts. With the UTM capability, the company added exception management logic to determine when a drone deviates from its planned mission and encroaches into controlled airspace. Another interface to the ATC system provides a means to notify controllers of the errant drone.

The interface to the ATC system Lockheed Martin has tested connects to its en route automation modernization (Eram) system, which the Federal Aviation Administration has installed at 20 en route centers nationwide that manage high-altitude traffic. “We took a copy of the Eram automation system and we implemented interfaces between flight services and Eram so that we can pass these exception situations over, and they can be displayed to controllers,” Glasgow said. “Most important, when we find that a UAS has left its area of operation and is now potentially in conflict with other, manned aircraft, we used Eram’s automatic conflict probe capability to determine the other aircraft that are potentially affected by this UAS. That gets displayed to the controllers, just as if they were getting an aircraft-to-aircraft conflict today between two manned flights.”

Modifications were made to ground station software of the two aircraft, allowing the operators to file flight plans and also to receive position reports from the UAS as they flew. If one of them left the airspace or was found to conflict with another aircraft, the ground station received an alert and the exception was communicated to the ATC system and displayed on an Eram monitor. The UTM aspect of the demonstration worked “perfectly,” Glasgow said.

“In the end, what this shows is a clear path forward with the combination of UTM services and some minor modifications to our ATC systems to allow the safe integration of UAS into the NAS,” Glasgow said.

<http://www.ainonline.com/aviation-news/aerospace/2015-12-08/lockheed-martin-simple-atc-mods-would-allow-drone-flights>

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## **Report cites 241 near collisions between pilots, drones**

WASHINGTON – There has yet to be a confirmed U.S. collision between a drone and a manned aircraft, but there's a growing number of close calls as drones fly where they least belong — near airports.

A report released Friday counted at least 241 reports of close encounters between drones and manned aircraft that meet the Federal Aviation Administration's definition of a near-collision, including 28 incidents in which pilots had to veer out of the way.

The FAA defines a near-collision as two aircraft flying within 500 feet of each other. In 51 of the incidents studied, the drone-to-aircraft clearance was 50 feet or less, the report said.

Most of the sightings occurred within 5 miles of an airport and at altitudes higher than 400 feet. Those are spaces in which the FAA prohibits drones from flying, raising questions about the effectiveness of the rules.

The cities with the most incidents were New York/Newark, New Jersey, 86; Los Angeles, 39; Miami, 24; Chicago, 20; Boston, 20; San Jose, California, 19; Washington, 19; Atlanta, 17; Seattle, 17; San Diego, 14; Orlando, Florida, 13; Houston, 12; Portland, Oregon, 12; Dallas/Fort Worth, 11; and Denver, 10.

The report is based on an analysis of government records detailing 921 incidents involving drones and manned aircraft between Dec. 17, 2013, and Sept. 12, 2015. Researchers cautioned that it's hard for pilots to judge their distance from another object when flying at high speeds.

The majority of the incidents, 64 percent, were sightings of drones in the vicinity of other aircraft with no immediate threat of collision.

Reports of drones flying where they aren't supposed to have increased dramatically. In May 2014, 10 incidents were reported to the FAA; in May of this year, there were 100 incidents. The FAA confirmed to the report's authors that the trend has continued, with 127 incidents in September and 137 incidents in October.

"With sufficient speed, bird strikes have been known to penetrate the cockpit," the report said. "It's entirely possible, then, that a drone could also break through into a cockpit, potentially causing serious harm to the pilots or other occupants."

The report cited research by engineers at Virginia Polytechnic Institute and State University in Blacksburg, Virginia, that used data on bird strikes to create computer simulations of drones striking planes in order to identify the riskiest impact locations. They concluded that hobby drones weighing between 2 and 6 pounds "can potentially cause critical damage."

The FAA is in the process of finalizing rules for the use of commercial drones weighing less than 55 pounds. The agency is also expected to shortly issue rules requiring the registration of small drones, including those used by hobbyists, in an effort to help create a "culture of responsibility" among drone operators. The agency is trying to get the registration rules in place before Christmas.

<http://www.foxnews.com/us/2015/12/12/report-cites-241-near-collisions-between-pilots-drones/>

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## **Stanford team develops software to predict and prevent drone collisions**

When Jeff Bezos unveiled his vision of drones delivering packages to Amazon customers during a 60 Minutes segment in late 2013, it caught many people as science fiction. Scarcely two years later, drones are poised to become a technology for not just delivering packages, but monitoring agriculture, gathering news in urban environments and even conducting search and rescue missions.

But before drone aviation can become pervasive, a new infrastructure must be developed to define low-altitude avenues of flight, regulate traffic in congested areas and prevent collisions.

"UTM is meant to fulfill a lot of the functions of air traffic control, but it will be in the cloud and largely automated," said SISL Director Mykel Kochenderfer <https://profiles.stanford.edu/mykel-kochenderfer>, an assistant professor of aeronautics and astronautics.

NASA envisions that the UTM system will be able to support the orchestration of a huge number of drone operations without air traffic control operators monitoring each and every vehicle in the air. A key attribute of this system will involve automated conflict avoidance – software that can alert multiple drones when a collision is possible, and calculate the maneuvers necessary to avoid it.

Today the Federal Aviation Administration has 15,000 human controllers to manage roughly 87,000 pilot-driven flights per day.

Amazon's drone projections alone could dwarf those numbers. Ong has conservatively estimated that Amazon Prime's roughly 40 million subscribers could generate 130,000 drone deliveries per normal shopping day. And that's before accounting for the dozens of other companies including Google and Matternet that are also developing commercial drone operations.

### **Avoiding conflict**

NASA envisions that the cloud-based, largely autonomous UTM system will roll out in a series of four builds with increasing capabilities. The first build, which was released in August, largely focuses on geo-fencing – GPS-based corridors for drone flights – to maintain safety and efficiency.

"That works for farming applications," Ong said. "But once you want to start moving transport drones around urban areas, you can't really do that, because you're not going to block out the airspace over entire residential areas just for when your aircraft is flying through."

The Stanford team believes that automated conflict avoidance is the best way to enable a greater density of flights in crowded areas. But automating conflict avoidance to deal with the volume of drone traffic will require new algorithms to predict and avoid potential collisions.

Beating 'the curse of dimensionality'

"In traditional aviation, conflicts between more than two aircraft are pretty rare," Ong said.

But in confined, urban airspaces, conflicts could easily involve three or more drones. For instance, consider several packages being delivered to the same address. Or imagine a blaze that draws multiple drones from the fire department, police and local media.

"As the number of aircraft grows, the avoidance problem becomes exponentially more complicated, a challenge that mathematicians call the curse of dimensionality," Ong said. "So we have to come up with better ways than just brute-force searching and iterating through all possible solutions."

To beat the curse, Ong's cloud computing architecture separates multi-aircraft conflicts into paired problems. It quickly picks the best action for each pair of drones from a table predicting each drone's flight path. The server then coordinates each of these pairwise solutions and issues a joint collision avoidance order to all of the affected drones.

In a matter of milliseconds, a dozen drones delivering Christmas Eve packages will know precisely what maneuvers to take to ensure each enjoys a safe flight path down a crowded cul-de-sac.

To test this approach, the researchers ran over 1 million simulations of encounters between two to 10 aircraft. They compared their pairwise solution to other solutions, such as a less-coordinated strategy in which each drone only reacts to its closest threat. Their pairwise solution showed significant safety improvements, faster decision times and decreased alert rates.

Ong and Kochenderfer said more work remains to be done, for instance, to account for communication breakdowns, sudden weather anomalies or deliberately disruptive drones. But they expect that an evolved version of their architecture will be implemented in one of the final builds of the UTM, which NASA estimates will be completed by 2019.

"It's gratifying to work on a problem that people are coming together and knocking heads and figuring out the best solution, even though there actually isn't a single profitable flight yet," said Ong, whose work was recognized in September as the best graduate student paper at the Digital Avionics Systems Conference held in Prague.

<http://news.stanford.edu/news/2015/december/drones-avoid-collisions-121015.html>

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### **GIS-related FAA drone exemptions represent 16% of first 2000 issued**

The FAA has yet to issue guidelines under which commercial drones or UAVs can operate, but that doesn't mean you can't legally conduct commercial drone flight operations. Exceptions are being granted for those companies or individuals that file a petition for exemption under the FAA's Section 333 [https://www.faa.gov/uas/legislative\\_programs/section\\_333/how\\_to\\_file\\_a\\_petition/](https://www.faa.gov/uas/legislative_programs/section_333/how_to_file_a_petition/)

Per the FAA's website: "As of March 23, 2015, the FAA will automatically grant a "blanket" COA (Certificate of Authorization) for flights at or below 200 feet to any UAS operator with a Section 333 exemption, provided the aircraft weighs less than 55 pounds, operations are conducted during daytime Visual Flight Rules (VFR) conditions within visual-line-of-sight (VLOS) of the pilot, and certain distances away from airports or heliports. Details are available here

<https://www.faa.gov/news/updates/?newsId=82245>

" A list of companies that have applied for and been granted Section 333 exceptions is available on the FAA's website <[http://www.faa.gov/uas/legislative\\_programs/section\\_333/333\\_authorizations/](http://www.faa.gov/uas/legislative_programs/section_333/333_authorizations/)> .

As of November 16, 2015, we conducted an informal analysis of the first 2000 granted exemptions. Our goal was to understand how strong the demand is for a UAV data-gathering tool in general, and for GIS and geospatial applications in particular, as well to understand how the demand varies across the country.

We began by defining the following categories:

- \* Photography — including filming, motion picture, cinematography, videography, television, aerial imaging and thermography.
- \* GIS & Geospatial — including survey, mapping, mining, remote sensing, orthomosaics, photogrammetry and landscape.
- \* Inspections — including construction, power line, pipe line, railroads and other utilities.
- \* Real Estate — all types.
- \* Agriculture, including precision, crop scouting, crop insurance and other agriculture.
- \* Insurance — including crop insurance and damage assessment.
- \* Search and Rescue.

It is important to note that the study was not strictly scientific; the accuracy of the results may have been affected by several factors:

1. The missions or applications listed in the Section 333 exemption application may not be the only ones that a company will ultimately perform, and
2. Some companies listed multiple missions. As an example, Utility Aerial Service in McLean, VA listed their mission as utility inspections, but Parametrix of Seattle, WA listed their missions as aerial photography, videography, surveying, photogrammetry and inspections. For the purpose of representation, we added one mission to the Inspection category in the case of Aerial Service, but for Parametrix, we added one mission for Photography (photography and videography), one for GIS (surveying and photogrammetry) and one for Inspections.

3. There are also the issues of defining categories and interpreting the correct category from mission descriptions.

#### Exemptions Granted by State

For the most part, exemptions granted by the FAA roughly tracked state population, but there were exceptions. For instance, despite having half the population of California, Florida had the highest number of granted exemptions. Virginia ranks twelfth by population but fourth by number of exemptions.

The cluster map below illustrates the number of companies granted exemptions in each state.

<http://media.directionsmedia.net/directionsmag/channels/articles/333map1.png>

#### Application by Industry Segment

Our research indicates that over 30 percent of the exemptions issued are for photography — no surprise there. But perhaps more interesting is that the GIS & Geospatial category ranked number two, at 16 percent. If we include agriculture to the GIS mix, it boosts the category to over 21 percent.

<http://media.directionsmedia.net/directionsmag/channels/articles/operationschart.PNG>

#### GIS and Geospatial Exemptions Granted by State

The cluster and point maps below illustrate location groupings and points for the exemptions granted for GIS & Geospatial applications across the country.

<http://media.directionsmedia.net/directionsmag/channels/articles/333map2.png>

<http://media.directionsmedia.net/directionsmag/channels/articles/333map3.png>

#### Drone Manufacturers

Companies filing for exemptions were required to list the drone models and manufacturers they planned to use for commercial work. The table and pie chart below ranks the top 15 UAV companies being used. The actual count far exceeds the total number of UAV manufacturers because many companies listed more than one drone manufacturer and, in some cases, more than one model from the same UAV manufacturer. As an example, uMap of Denver indicated they were going to use the DJI Phantom 3, DJI S1000+, senseFly eBee, and senseFly eBee RTK. This conflated into two counts for DJI and two for senseFly.

<http://media.directionsmedia.net/directionsmag/channels/articles/333chart2.PNG>

The table and pie chart below show the top 15 manufacturers of the drones being used for GIS & Geospatial applications.

<http://media.directionsmedia.net/directionsmag/channels/articles/333chart3%281%29.PNG>

## Summary

After analyzing over 2000 records of Section 333 exemptions granted by the FAA, the research shows that over 16 percent of all granted exemptions were GIS or geospatial related, and that number increases to over 20 percent when agricultural applications are added. The dominant UAV company, regardless of application, was DJI. 3D Robotics was second.

Based on this research, it would certainly seem that inexpensive UAVs will disrupt the GIS & Geospatial industry. It's a game-changer that is not only rippling through the hardware segment — light weight cameras and other sensing devices — but is also driving down software costs.

In the coming months we'll take a closer look at the different GIS categories to determine which specific segments are, or will be, positively affected by commercial drone flights. We'll also examine the types of UAVs, fixed wing or copter, being used for GIS applications.

Additional Note: Starting next Monday, December 21st, the FAA

<https://www.faa.gov/uas/registration/faqs/> is requiring all UASs weighting less than 55 pounds and more than .55 pounds to be registered. Owners of drones purchased prior to December 21, 2015 will have 60 days to register.

<http://www.directionsmag.com/entry/gis-related-faa-exemptions-only-16percent-of-first-2000-issued/459749>

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## **PUBLIC SAFETY:**

### **Insurance market delves into UAS technologies**

Cunningham Lindsey has announced a partnership with VDOS Global to incorporate unmanned technologies into insurance provider processes.

VDOS is an FAA-authorized provider of UAS services. Under this partnership, the two companies will work together to leverage the efficiencies offered by UAS for the daily claims processes undertaken by insurance companies.

Insurers will be supported in the creation of UAS programmes for their claims processes, with the aim providing safer pre- and post-loss assessments with aerial flyovers, and customised UAV-training tailored to the needs of field adjusters and additional experts seeking certification.

Carriers will also be able to access aerial data in support of application and underwriting, as well as catastrophic claims situations for all types of property. When claims occur that require a forensic investigation, VDOS will also work with EFI Global (EFI), the forensic division of Cunningham Lindsey, to provide the UAVs needed to gather field data in challenging locations.

David Repinski, president and chief client officer, Cunningham Lindsey, Americas, said: 'We are excited to partner with a highly respected and recognisable brand like VDOS to share the benefits of the emerging drone technology with our clients.

'It is undeniable our industry is changing constantly, and the data application possibilities using drone technology are tremendous. This partnership represents the best path forward to help insurers incorporate a UAV strategy to gain a competitive and differential advantage across all channels in the claims and risk assessment process.'

<https://www.shephardmedia.com/news/uv-online/cunningham-lindsey-introduces-uavs-insurance-marke/>

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## **Rules, Safety and the Future of Drones**

As infrastructure struggles to keep up with the congestion that comes with growing demand, new technological developments are on the horizon that could help relieve some of that burden and improve the efficiency of global supply chains. Within the next five years, drones could become widely used to help transport goods. But rapid advancement and keen industry interest aside, the realities of regulation and technological constraints will limit the role of drones in delivering goods to customers in the United States, at least in the short term.

In 2012 the U.S. Congress instructed the Secretary of Transportation to "establish requirements for the safe operation of [unmanned] aircraft systems in the national airspace system." Three years later, the Federal Aviation Administration (FAA) responded by releasing its proposed rules of operation. The 195-page document, published in February, contained both laudable and questionable stipulations, but one overarching concern received the most attention: safety.

For any new airspace regulation, the FAA is required to consider three criteria: the safety of the aircraft, the efficient use of airspace, and the protection of people and property on the ground. Based on the proposed regulations, FAA officials are going to great lengths to ensure that drones can operate safely around other aircraft and people, even when pilots are far away. The new rules, if passed, would require operators to keep drones within their line of sight throughout the entire flight.

The line-of-sight requirement reflects the FAA's long-standing rules on determining right-of-way in the air, which mandate that operators stay vigilant "so as to see and avoid other aircraft." In modern manned aircraft, cockpit and control tower technologies have advanced enough to enable planes to stay separated and avoid hazards without needing the pilot to maintain visual continuity. The development of technologies that provide an equal level of safety assurance will be critical to making drone flight feasible in congested urban areas.

<http://mandrillapp.com/track/click/7958185/www.stratfor.com?p=eyJzljoimVBpbGQwTUVEbHJNN2F5ZVdodU9vNVprRHMwliwidil6MSwicCI6IntclnVcljo3OTU4MTg1LFwidlwiOjEsXCJ1cm>

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## **World's First Professional Grade Unmanned Aerial Vehicle for Broadcast, Motion Picture, Law Enforcement**

LOS ANGELES, Dec. 9, 2015 /PRNewswire/ -- SHOTOVER, the maker of high performance stabilization platforms, announced today the debut of the SHOTOVER U1, the world's first professional grade unmanned aerial vehicle (UAV) for the broadcast, motion picture, law enforcement and industrial survey markets. The U1 sets a new standard for drone cinematography and imaging as the first solution to accommodate cinema quality cameras and lenses including the 6K RED Weapon, ARRI Alexa Mini, Phantom Flex4K and Sony F55 cameras and the Canon 17-120mm, Fujinon 85-300 and Optimo 28-76 lenses. This flexibility allows operators to carry the right payload for whatever the mission requires.

Further increasing functionality, the SHOTOVER U1 gimbal (U1g) can be detached from the multirotor and used as a standalone gyro-stabilized platform for mounting on motorcycles, cars, boats, cables and almost anything that moves. Buyers can choose between the U1, which includes both the multirotor and gimbal, and the U1g, which is the gimbal without the aerial component. Other U1 features include redundant flight control and battery systems, customized down-link with two HD video feeds and unparalleled stability even at full zoom. Pre-orders for the U1, which will begin shipping in Q1 2016, have already topped several dozen units.

The U1's redundant battery system with on screen feedback of cell voltage and capacity allows the pilot to turn off a failed battery cell and get the ship home safely. And the redundant flight control system provides operators with the ability to quickly switch to a back-up flight controller if the need arises. Additional features of the U1 include a user friendly design that allows operators to easily swap cameras and lenses during a shoot, 10X more pan motor torque than prosumer gimbals and a unique balancing system for unshakable stability. Like all SHOTOVER systems, the U1 has no ITAR restrictions, enabling it to be shipped around the world without requiring U.S. State Department approval.

<http://www.prnewswire.com/news-releases/shotover-takes-drone-cinematography-and-imaging-to-new-heights-with-launch-of-shotover-u1-worlds-first-professional-grade-unmanned-aerial-vehicle-for-broadcast-motion-picture-law-enforcement-and-industrial-survey-markets-300190258.html>

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## **Drone retailer to open at N.J. mall to feed growing market**

PARAMUS — Drones are coming to the mall.



Expert Drones, a Washington, D.C. retailer of drones, plans to open a store in early 2016 at Westfield Garden State Plaza.

Drones can be found at department stores, chains like Brookstone and online, but Expert Drones claims to be the first brick-and-mortar retailer dedicated to the unmanned flying machines. The store offers a wider selection than less-focused competitors, Brett Velicovich, one of the founders of Expert Drones, said.

"We're authorized dealers of a bunch of different high-end manufacturers," Velicovich said.

An analysis of FAA data shows New Jersey is among the top 10 states reporting improperly flown drones, or unsafe close encounters with other aircraft.

Expert Drones' inventory ranges from micro-drones with cameras the size of 50-cent coins that cost as little as \$40, to mid-range best-sellers like the DJI Phantom 3 Professional, going for about \$1,000, to higher-end models with advanced cameras that can cost as much as \$4,000.

Aside from sales, Expert Drones customers can also service their drones at the stores and sign up for training classes.

Sales of consumer drones were expected to reach 400,000 units in 2015, according to research from the Consumer Electronics Association. The revenue from drone sales is expected to exceed \$1 billion in five years.

The real estate industry uses drones to showcase properties from the air; surveyors, photographers and farmers also employ them, according to an industry study obtained by USA Today. A farmer once called Expert Drones asking how to track wild pigs on his property, Velicovich said.

"If you can think of an industry that exists, there's a reason to use a drone for it."

The store is opening just as the Federal Aviation Administration is looking to impose new rules regulating drones, including a requirement that all unmanned aircraft be registered. Steve Cohen, president of the 20,000-member Drone User Group, says many manufacturers are including built-in limitations to anticipate those rules. For example, some drones have pre-loaded maps that keep them from flying near airports or prisons.

Drone User Group and another organization, the Academy of Model Aeronautics, encourage their members to follow a set of guidelines for safe flying compiled by the FAA. Cohen encourages retailers to include the "Know Before You Fly" guideline with receipts. He plans to reach out to Expert Drones to do the same.

Feds want all drones to be registered

As the popularity of drones has increased, the government has been concerned with the number of drones near some of the largest airports in the country.

Many people don't realize that any commercial use for drones has to be approved by the FAA, and that anyone flying a drone for commercial use has to be a licensed pilot. The new FAA rules will likely include a separate license for drones, Cohen said.

Cohen said the Drone User Group was in favor a regulatory framework.

"Regulation is a good thing," he said. "It protects consumers."

[http://www.nj.com/bergen/index.ssf/2015/12/drone\\_retailer\\_to\\_open\\_at\\_nj\\_mall\\_to\\_feed\\_growing.html](http://www.nj.com/bergen/index.ssf/2015/12/drone_retailer_to_open_at_nj_mall_to_feed_growing.html)

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### **Drone sales booming, creating a headache for the FAA**

Every Monday in Fort Collins, visit the football field at Lincoln Middle School and you'll see a dozen or so radio control hobbyists, donning first-person view goggles piloting small drones that zip through the goalposts and whirl over the trees at nearly 70 mph.

Fascinated with the technology, the Colorado State University graduate began building four-propeller drones, or UAVs — unmanned aerial vehicles — about two years ago, just as the skyrocketing drone craze began. Zelener's drone enthusiasts group has grown to about 180 members — and soon could see a rush of new members to the weekly meetups as giddy new drone owners open their shiny toys Christmas morning.

Some 400,000 recreational drones, priced between \$40 and \$1,600, are expected to fly off retailers' shelves this holiday season. For the year, the Consumer Technology Association estimates about 700,000 will be sold, up 30 percent from last year.

Bracing for the potential onslaught of unmanned aircraft soaring through the sky, the Federal Aviation Administration is scurrying to launch a drone registry before those drones are even unwrapped. The aim is to regulate hobbyists and reduce aerial dangers such as close calls with airplanes.

Under the proposal, released last month, drone owners would have to register the machines with the federal government, entering their name and home address in a national database, the first such requirements. Lose track and crash your drone, and authorities will be able to trace it back to you — and you could face potentially serious consequences.

The proposal, expected to be approved before Christmas, would be the biggest step yet by the government to deal with the proliferation of recreational drones, which are usually used for harmless flights around the neighborhood, but also pose a risk to airborne jets and raise concerns about privacy.

Currently, hobbyists can fly drones with few restrictions — as long as they are at least five miles away from an airport, out of no-fly zones, flying below 400 feet and keeping their drones in sight.

Easier than ever to fly

RC Hobbies Fort Collins sells drones for as little as \$40 — tiny quadcopters used for indoor flying only. Some of the most popular models, Knuckles said, are in the \$100-\$150 range and don't come equipped with a camera.

"You can do some basic aerobatics with it. Flips and rolls, those sorts of things," said Knuckles, a longtime flyer of remote controlled model airplanes. He said pilots of radio-controlled aircraft tend to self-police, and know the risks both to planes and people on the ground.

Technological advances, including GPS navigation, have made drone flying easier than ever, Zelener said.

With a GPS-enabled drone, new operators might skip essential steps such as calibrating the drone before flying it. Failure to do that can mean the drone misinterprets "home" and simply flies out of sight and falls out of the sky whenever the battery dies.

The FAA has received hundreds of complaints in the past two years about drones endangering planes, interfering with wildland firefighters and entering secure airspace. In September, a New York City teacher was arrested for allegedly crashing a drone into an empty section of seats at the U.S. Open.

The concern from pilots is that if a drone collides with an aircraft engine, it could disable the engine much like birds do when sucked into engines.

Autonomous Nation hosts free drone pilot classes every 60 days, teaching safe flying techniques. About 30 people attend each session, De La Cruz said, most of whom own drones with the intent of offering services like photography or aerial surveying.

Commercial drone operations take flight

The Association for Unmanned Vehicle Systems International, a nonprofit industry group that promotes the commercial use of unmanned aerial vehicles, estimates that once UAVs safely integrate with airports and flyways for manned aircraft they will generate more than \$80 billion of business by 2025.

Among the notable uses will be agriculture, with drones checking for yields and spraying crops and package delivery, via Amazon's Prime Air. Already, Northern Colorado photographers and real estate agents use drones to provide aerial photos of properties, and roofers use drones to survey rooftops — without having to use a ladder. Other potential drone uses include search and rescue and law enforcement.

Commercial drone operators must apply for special approval to fly from the FAA, known as a Section 333 exemption. More than 2,500 companies have received the exemption, which requires commercial drone operators possess an actual pilot's certificate, the same needed for piloting a small fixed-wing aircraft. The requirement may change to one that instead asks commercial drone users to pass an aviation knowledge test.

De La Cruz said the FAA's proposal to register all drones is a good first step, but he'd like more regulation. His proposal: a required license and registration system, just like we use for our vehicles.

“You should have to take a test. Can you proficiently get this thing off the ground and fly and land it safely?” De La Cruz said. “Drones, they’re an amazing technology. Now, let’s take care of it.”

Drones and the outdoors don’t mix

Some 400,000 drones are expected to be sold this holiday season. The FAA is heavily promoting these safe flying regulations at [knowbeforeyoufly.org](http://knowbeforeyoufly.org). Stephen Meyers/The Coloradoan

Also last year, Colorado Parks and Wildlife banned the use of drones for scouting game.

Drones are permitted in the national forest, unless there are temporary flight restrictions, such as during a wildfire.

“I get it. People are outside for a reason. I was concerned that people were going to be concerned about their safety, or annoyed by this drone flying above them. But overwhelmingly, I’ve found that every time I’ve flown my drone, people have been fascinated by it,” Zelener said.

Know before you fly

While it is OK to fly a drone in your home, or a microdrone outside, the FAA’s regulations on flying drones currently include:

- No flying above 400 feet
- Keep the aircraft within visual line of sight at all times
- Remain well clear of, and do not interfere, with manned aircraft operations
- Never fly within 5 miles of an airport, unless you first alert air traffic control or the airport authority
- No flying over any other person not involved in the flights, which means no flying over strangers at the park or in a parade. Experts say the rule regards both privacy and safety, preventing drones from crashing on people’s heads.

Source: [knowbeforeyoufly.org](http://knowbeforeyoufly.org)

<http://www.coloradoan.com/story/news/2015/12/11/drone-sales-rise-creating-problems-faa/77156466/>

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## **UAV’s Role in Protecting the Exclusive Economic Zone**

The use of the definition Exclusive Economic Zone (EEZ) has become common in recent years. Countries understood that there are many threats on their maritime natural treasures and wanted to draw a line that will make it easier to protect these treasures.

In order to protect something that belongs to a country but is located a good distance from the shore, you need surveillance – a persistent one.

Maritime surveillance requirements, are demanding specific capabilities and performance such as mission endurance, flight profiles, mission equipment and human factors.

Until recently, such missions were performed exclusively by aircraft – some dedicated for the maritime surveillance mission, with others using off-the-shelf transport planes modified for the mission. These missions typically demand coverage of very wide areas, monitoring extensive maritime traffic, as well as deployment in unexpected conditions, in response to emergencies or on search and rescue missions. Therefore, the need for efficient development of a maritime situational picture is critical, enabling the deployment of the few available aerial assets to cover only those areas or targets of significance.

The introduction of unmanned air vehicles systems (UAV) is changing this paradigm, removing the limitations that have restricted manned missions, while introducing new capabilities that significantly enhance operational flexibility and efficiency of maritime control. This capability is specifically important in recent years, as countries are required to cover growing maritime areas claimed by the EEZ. These can be located up to 200 nautical miles from their coastline or farthest island. In the case of India, for example, such area covers a huge expanse of the Indian Ocean, bordering Indonesia in the east to Somalia in the west. A country cannot cover such vast space from its coastal radar stations, nor can it commit manned patrol flights to cover the entire area.

[http://i-hls.com/2015/12/uavs-role-in-protecting-the-eez/?utm\\_source=Israel+Homeland+Security+%28iHLS%29&utm\\_campaign=7cca881eb7-ENGLISH\\_DYNAMIC&utm\\_medium=email&utm\\_term=0\\_8ee2e16ed1-7cca881eb7-89865369&mc\\_cid=7cca881eb7&mc\\_eid=532334b8e8](http://i-hls.com/2015/12/uavs-role-in-protecting-the-eez/?utm_source=Israel+Homeland+Security+%28iHLS%29&utm_campaign=7cca881eb7-ENGLISH_DYNAMIC&utm_medium=email&utm_term=0_8ee2e16ed1-7cca881eb7-89865369&mc_cid=7cca881eb7&mc_eid=532334b8e8)

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## **University of Iowa, Rockwell Collins working on autonomous drone tech**

What happens if an unmanned aircraft gets disconnected from its operator mid-flight?

Most likely, it falls out of the sky. That is unless it somehow knows what to do by itself in such a situation.

Researchers at the University of Iowa and Rockwell Collins are pursuing that notion. Together, they are working to develop a way for unmanned aircraft — commonly referred to as drones — to autonomously fly themselves to safety should an operator lose control.

Autonomy will also come into play, Schnell said, if an unmanned vehicle flies near or into an obstacle, such as ice.

"Unmanned aircraft don't know these rules yet," Schnell said. "They can't really see and avoid other than some very preliminary prototype systems. They're a long way away from seeing and avoiding the way a human can and the way a human and air traffic control can."

While some companies are already using unmanned vehicles, the ones commonly in use are of a smaller size, cannot carry much of a payload and are limited in how high up they can fly. Larger drones that fly outside of an operator's line of sight will require more sophisticated technology and software.

Certified technology will help advance the use of unmanned aircraft, but it won't eliminate the need for a human pilot on the ground or safety concerns should a drone lose its connection. That's where an autonomous system would come into play.

"Making the autonomous vehicles so they can make decisions without humans supervising them at every step, that's a much more long-term and much more challenging issue," Postnikov said.

<http://www.desmoinesregister.com/story/tech/2015/12/13/ui-rockwell-collins-working-autonomous-drone-tech/77032394/>

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### **Five Government Drone Projects Waging Research**

Hurricane Sandy changed the game for the National Oceanic and Atmospheric Administration. Following Congress' passing of the Disaster Relief Appropriations Act in response to the October 2012 "super-storm," some \$27 million in funding was allotted to improving NOAA's observation systems, which included the fledgling Unmanned Aircraft Systems (UAS) Program. Following its launch in 2008, the UAS Program subsisted on meager support from the government. Today, thanks to the Sandy funds and the explosive growth of drone technologies, the program runs on about \$5 million and is continuously building partnerships with other federal agencies, private companies, and universities across the United States.

"Unfortunately," says Joe Cione, a meteorologist in NOAA's Hurricane Research Division who led the first-ever UAS flight into a tropical system in 2005, "it takes a disaster to do new, innovative stuff." Few in the government paid attention to Cione's successful 2005 UAS flight, but after Sandy he suddenly had \$1.2 million and five Coyotes—thirteen-pound, five-foot-wingspan electric drones that can fly at far lower altitudes than manned Hurricane Hunter P-3 aircraft. It can also transmit observations like wind speed, pressure and temperature to National Hurricane Center forecasters in real time.

According to UAS Program Director Robbie Hood, there are now about a hundred drones being shared between several federal agencies, such as the Forest Service and Coast Guard, for research applications. "Eight years ago, a lot of the UAS you saw were developed through military investments," says Hood. "Now we're seeing more and more innovation coming from a civilian earth science point of view."

"Is it cheaper for us scientists to do this work?" Hood says of the UAS Program's core question moving forward. "Or is it cheaper to use UAS?"

## SHOUT Project

In the mid-2000s, NASA adopted some of the military's Global Hawks—the massive, \$220 million-a-pop, wasp-like drone used for surveillance—and dumped their deadly payloads. With their ability to fly above 55,000 feet for up to thirty hours, the retrofitted Global Hawk's Doppler radar and atmospheric sensors have allowed better measurements of hurricanes' energy, inner-core structures and behaviors through a NOAA/NASA collaboration called Sensing Hazards with Operational Manned Technology project (SHOUT). And in 2014, Joe Cione's team deployed

[http://www.aoml.noaa.gov/keynotes/keynotes\\_0914\\_coyote\\_success.html](http://www.aoml.noaa.gov/keynotes/keynotes_0914_coyote_success.html) four Coyotes from a P-3 Hurricane Hunter into Eduoard, a Category 3 hurricane off the U.S. East Coast, to take detailed observations below 3,000 feet, where manned aircraft cannot safely fly. "There are all kinds of interesting atmospheric details down there that we were only guessing about," says Cione. "With the Coyote, we can go in there and transmit that data directly to the National Hurricane Center so that they can then apply it to their forecasting models, which could lead to the evacuation of a community" that might have been ignored otherwise.

## Operation Arctic Shield

As Arctic sea ice disappears, the world's super powers are increasingly competing for shipping and oil drilling dominance. Over the last four years, NOAA has joined Operation Arctic Shield—the U.S. Coast Guard's annual deployment in the Arctic Ocean and Bering Sea—in order to test the Puma AE <http://uas.noaa.gov/shout/NOAA%20USCGC%20Healy%20UAS%20Test%20Plan%20and%20Operational%20Assessment%202015%20070915.pdf> a 13-pound, fixed-wing drone. Scientists, data specialists and researchers from the UAS Program, the National Ice Center, and the USCG Research and Development Center have been exploring the Puma's monitoring capabilities in areas too difficult or dangerous to reach for ships or manned aircraft. By equipping the Pumas with live-feed cameras and infrared sensors, the group is looking at how UAS can improve search and rescue missions, the tracking of oil spills, and the mapping of sea ice. "Arctic observations are going to be critically important to understanding climate change," says Robbie Hood. "Once you change the sea ice structure, that changes the way the atmosphere and the oceans work, which impacts the weather."

## Marine Monitoring

Drones don't just fly now—they swim <http://sanctuaries.noaa.gov/news/press/2015/unmanned-system-for-research.html>. This past February, in the Hawaiian Islands Humpback Whale National Marine Sanctuary, NOAA synched Puma flights with underwater Wave Glider drones, a wave- and solar-powered "unmanned ocean robot," on patrols. Researchers from NOAA's Office of National Marine Sanctuaries used the Wave Glider's acoustic sensors to ping a test vessel and relay that data to the Puma, which then located and photographed the target. The exercise proved that combined drone technologies could also be applied to the tracking of marine life, such as the endangered humpback, or surveying the sanctuaries in their entirety—endeavors that, when attempted with manned aircraft or ships, are too costly and time-consuming to be viable.

## Surveying Endangered Wildlife

The web went gaga last month when NOAA Fisheries and the Vancouver Aquarium released photos [http://www.nmfs.noaa.gov/podcasts/2015/10/uav\\_killer\\_whale.html](http://www.nmfs.noaa.gov/podcasts/2015/10/uav_killer_whale.html) , taken with a small hexacopter drone, of Southern Resident killer whale families in the waters around the San Juan Islands, north of Seattle. Killer whales aren't the only endangered wildlife being watched by drones. During a three-month seafloor-mapping cruise in the Hawaiian archipelago this summer, NOAA field researchers used Puma drones to photograph endangered monk seal populations. In the Gulf of Mexico, drones' high-resolution cameras are mapping sea turtle habitats. "We've seen early on that the UAS are so quiet that they don't generally bother the wildlife," Hood says. "Our biologists are really excited, because they're able to get a better view of the wildlife than they did before. In the long run, we'll have a more accurate assessment of how [habitats] are changing."

#### River Forecasting

NOAA is watching our rivers, too. Beginning in 2011, NOAA's Northern Gulf Institute teamed up <http://grad.msstate.edu/spotlight/hathcock.php> with the Mississippi State Geosystems Research Institute to use Pumas and another similar-sized drone, called the Nova, to photograph and map Louisiana's vast, difficult-to-penetrates Pearl River Coast Watershed. "We're going out every other month and flying over this region, looking for [foliage] changes," says Hood. The goal is to gather more observations on areas of drought and saturation, as well as flooding characteristics. "So, if you have a flooding situation, forecasters will have a better understanding" of the river's behavior.

<http://www.outsideonline.com/2041421/five-government-drone-projects-waging-research-not-war>

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### Three Miles High: Using Drones to Study High-Altitude Glaciers

SAN FRANCISCO—While some dream of the day that aerial drones deliver their online purchases, scientists are using the technology today to deliver data that was never available before.

About 5,000 meters high in the Peruvian Andes, the scientists are mapping glaciers and wetlands in the Cordillera Blanca mountain range with 10-centimeter precision to gauge how climate change will affect the half-million local residents who rely in part on those glaciers for their water supply.

Though the study is just beginning, one early finding is that the Cordillera Blanca has a healthy groundwater system, said Oliver Wigmore, a doctoral student in geography at The Ohio State University.

"In this area, glacier melt provides up to 50 percent of the water during the dry season, and people use it for farms, hydroelectricity and to drink," he explained. "We know the glaciers are disappearing, so there will be less water available for the dry season in the future. But what my colleagues and I have found is that the groundwater system is storing some of the glacier melt as well as precipitation. There will still be a significant drop in water supply eventually, but there may be some potential for the groundwater to buffer it."



Wigmore also presented measurements that suggest a key glacier in the region's Llaca Valley is changing rapidly. He recorded an average of 0.7 meters of thinning in one year with a maximum of 18 meters of loss in some locations. For example, an ice cliff at the leading edge of the glacier collapsed over a two-week period early in 2015.

That's the bad news. But the good news about the groundwater system would have been very hard to obtain without special high-altitude unmanned aerial vehicles (UAVs) that Wigmore designed and built, and time-lapse thermal camera systems that colleague Jeffrey McKenzie at McGill University developed.

With Ohio State Associate Professor of Geography Bryan Mark, Wigmore, McKenzie and their team are using technology to overcome the clouds, rough terrain and thin air that prevent easy access to ice on the Cordillera Blanca.

"All glaciers are a really important source of information about climate, whether it's the amount that they are receding or past history from ice cores," he said. "But right now, we're acutely concerned for the water resource that they contain. All over the world, glaciers are close to rapidly expanding urban areas and extensive agriculture, both of which need water."

The Ohio State UAVs have a 10-centimeter resolution, work despite frequently cloudy conditions in the mountains of Peru and cost a few thousand dollars each. In contrast, satellites provide a half-meter resolution at best, work only during the two months a year when the region is relatively cloud-free and cost millions of dollars.

Wigmore equipped the large, lightweight drones with high-speed motors and extra long propellers to carry them through the thin air. (Should he try to fly one at sea level, the motors would immediately burn up, he explained.)

Flying about 100 meters above the ice and wetlands, the UAVs take hundreds of pictures that overlap, providing 3-D imaging the way a pair of human eyes provide depth perception.

As to the early data, which researchers are still processing, Wigmore described the Llaca Glacier's ice loss and collapse of the calving front as more dramatic than he would have expected.

McKenzie's research team is using thermal infrared cameras to monitor glacier in Peru over time. These cameras, which essentially take pictures of temperature, allow his team to carefully observe what sections of glaciers are melting fastest.

"These new technologies, combined with the UAV mapping, are allowing us to observe glaciers in ways that we would never have thought possible even a couple of years ago. It is really an exciting time to be involved in this research," McKenzie added.

Whereas airplane surveys cost hundreds of thousands of dollars, and satellites cost millions, he can build a UAV for around \$4,000.

The low cost is definitely a good thing, he added.

Wigmore adds on-board sensor systems that map the earth in visible light, near infrared and thermal infrared. Most of the cameras cost around \$400 each. One thermal camera costs 10 times as much, but was donated to the project by electronics company DRS Technologies. A differential GPS system—very important for accurate ground control data—would normally cost tens of thousands of dollars, but the nonprofit consortium UNAVCO provided one for the portion of the study done in 2014. In 2015, Wigmore was able to borrow a differential GPS from Ohio State’s Byrd Polar and Climate Research Center.

This research is funded by the National Science Foundation.

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**<http://www.newswise.com/articles/three-miles-high-using-drones-to-study-high-altitude-glaciers>**

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### **SENSORS/APPLICATIONS:**

#### **A Glimpse at Tomorrow’s Electromagnetic Spectrum Weapons**

In conflict zones from Europe to the Middle East, the electromagnetic spectrum has assumed a central place on the modern battlefield. In eastern Ukraine, Russian-backed forces have used sophisticated jamming and interception tactics to undermine communications and surveillance drones. And after Turkey shot down a Russian fighter jet over the Turkish-Syrian border, Russia deployed its S-400 air defense system, whose advanced surveillance and engagement radar can guide missiles to targets nearly 400 kilometers away. The jammers in Ukraine and the radar in Syria represent two sides of the same technology — a field the United States is now losing its edge in, according to Bryan Clark and Mark Gunzinger from the Center for Strategic and Budgetary Assessments.

Here’s a brief glimpse of how Clark and Gunzinger say the electromagnetic spectrum will change warfare:

Drones and decoys: Useful for more than loitering over a target and lobbing Hellfire missiles, drones will be used to launch jamming or hacking attacks at short distances. (An example would be this drone that does penetration testing.)

The key is the unmanned aircraft's ability to sneak up on an adversary. The closer you are physically to the target, the less power you need to use, which makes your electronic warfare operation harder to detect and counter.

"The U.S. military could shift toward using unmanned vehicles or expendable payloads that emit low-power jamming noise in the [radio frequency] spectrum ... or dazzling [electro-optical / infrared sensors] or narrowly focused radar beams to establish accurate targeting information for attacks," the authors write.

But Clark and Gunzinger see another use for drones: as decoys meant to provoke the enemy to activate his fire-control radar and thereby reveal its position.

Here's how they describe it: "Use passive sensors to detect enemy [radio frequency and infrared emissions.] Locations of enemy emitters can be determined by triangulating emissions received by multiple, dispersed manned or unmanned platforms or by analyzing the Doppler shift of [electromagnetic] emissions received by passive sensors. It is likely that some targets, such as fire control radars, will only emit after receiving a cue from a sensor...the U.S. military could use emitting decoys to cause fire control radars to activate, allowing passive sensors to geo-locate them."

Stealthier sensors: Lasers aren't just useful for burning holes in things. Light Detection and Ranging lasers, or LIDAR, is how self-driving cars see the road. The same principle could be used to detect objects that we today hunt with radar — using tightly focused laser beams that are harder to detect than radio signals.

In 2013, the Defense Department released its electromagnetic spectrum strategy <http://www.defenseinnovationmarketplace.mil/resources/dodspectrumstrategy.pdf>, detailing how it intended to win the wars in the modern contested spectrum environment. But while the United States is strategizing, other countries are gaining real-world experience.

<http://www.defenseone.com/technology/2015/12/glimpse-tomorrows-electromagnetic-spectrum-weapons/124114/>

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## **Terrafugia takes unmanned turn**

Terrafugia is still working to bring the Transition, its first "street legal aircraft," to market, but moving forward in the meantime with the next big thing at a scaled-down size. The final Transition conforming prototype is slated to be tested in 2016 and 2017, and Terrafugia engineers are meanwhile tweaking the design for the TF-X, which aims to be capable of vertical takeoff and landing, thrust provided by

articulating engine pods that rotate between hover and cruise positions. Before strapping a test pilot in, they will try radio controllers first, the company announced.

The TF-X was first announced in 2013 and will remain on the drawing board while the Terrafugia waits for regulators to determine how, exactly, the semi-autonomous aircraft will be certified. The design will soon enter the world at one-tenth scale, sans pilot, and, it turns out, still months ahead of new FAA regulations for commercial operation of unmanned aircraft. The Woburn, Massachusetts, firm founded by MIT graduates followed the lead of thousands of photographers and videographers, securing permission after petitioning the FAA for relief from compliance with applicable federal aviation regulations under Section 333 of the 2012 FAA Modernization and Reform Act.

Put another way, the company followed a trail blazed by hundreds of wedding photographers, aerial surveyors, and others who have found use for unmanned aircraft in the course of their business.

It is tempting to nickname the unmanned version of TF-X “inanibus,” the most likely word offered by Google as a Latin translation of “unmanned” suitable to the context. The company name, after all, is Latin for “to break free from the ground.” There was no discussion of this, however, in the Dec. 1 press release announcing approval to fly the scale version of the coming four-seat aircraft made with city streets and tight spaces in mind. The company did note that the TF-X remains at an early stage of development, and the unmanned model will enable testing of various flight characteristics including hover stability. The company pledged full compliance with authorities and limitations including a 400-foot ceiling for the unmanned scale model, along with a 100 mph speed limit.

The design also will be refined with help from more traditional tools including wind tunnels and computer models.

<http://www.aopa.org/News-and-Video/All-News/2015/December/2/Terrafugia-takes-unmanned-turn>

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### **3D Scanning Drone Revolutionizes Tasks**

2-Dec-2015 A recent video released by Nvidia shows a drone 3D scanning a French chateau in real time simply by flying in front of it, using a Stereolabs' ZED depth sensor and the newly announced Nvidia Jetson TX1 GPU platform.

Doing so marks the first time stereo 3D Simultaneous Location and Mapping (SLAM) was achieved on a drone, where power and weight limitations have until now been stifling.

How the drone saw the French chateau as it flew around the exterior.

Since its launch this past May, ZED has already attracted buyers from R&D labs in major semiconductor, automotive and robotics companies, in addition to hobbyist developers. The ZED is also being integrated

into MIT's robotics class, and has been used by graduate students since its launch to develop autonomous vehicles that navigate urban environments.

To make things easier, the 3D SLAM feature will be added to the existing ZED SDK, giving every developer access to depth, tracking and mapping data. This makes it easy for any machine to understand its position and free space, and eventually it will be easy to choose its future trajectory.

"The ZED camera is a great demonstration of what is possible with the Jetson TX1" said Deepu Talla, VP and GM for Tegra at Nvidia. "The Jetson community of developers is excited by what Stereolabs has achieved here."

The Nvidia Jetson TX1, which provided the graphics processing power for this demonstration, is an embedded GPU platform that provides advanced GPU computing on a module roughly the size of a credit card. Using Maxwell architecture, the platform delivers a full teraflop of performance with minimal power requirements, with special features designed to support artificial intelligence and machine learning.

<http://www.cgw.com/Press-Center/In-Focus/2015/3D-Scanning-Drone-Revolutionizes-Tasks.aspx>

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### **Laser camera can track hidden moving objects around corners**

Now there's nowhere to hide. A camera that can detect individual photons is able to track objects moving around corners, even when they are completely obscured from view. The device could be used for search-and-rescue missions, or installed on cars to detect incoming vehicles.

The camera was created by a team led by Daniele Faccio of Heriot-Watt University in Edinburgh, UK. It can log the position of a photon in a 32-by-32 grid at the equivalent of 20 billion frames per second. This high precision previously allowed the researchers to make a movie of a laser beam in flight, but now they've developed a new trick to detect moving objects that are hidden.

First, they fire a laser at the floor near the corner they are trying to see around. The light bounces off the ground and produces a spherical "echo" of just a few photons. That would normally be too faint to see, but the ultra-sensitive camera can pick it up.

As the echo expands, part of it travels around the corner and hits the hidden object – in the team's tests, a 30-centimetre-high foam human model nicknamed "Terry". It then bounces off the object, creating another echo. This also expands and part of it enters the field of view of the camera, which sits next to the laser.

High pulse rate

The researchers conducted their experiments in the dark, but using an infrared laser and filter should allow the system to work in normal light, says Gariepy.

They are also working on a portable system that can detect objects over longer distances and many at once. This would make it useful for scanning buildings in search-and-rescue missions, or acting as an early-warning system for cars turning into blind corners. "We would like to bring it forward and have it closer for people to use in applications," says Gariepy.

<https://www.newscientist.com/article/dn28628-laser-camera-can-track-hidden-moving-objects-around-corners/>

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### **FLIR Systems teams with DJI Innovations**

FLIR Systems has entered into a technology collaboration agreement with UAV manufacturer DJI Innovations, FLIR Systems announced on 10 December.

The companies intend to develop a joint product, the Zenmuse XT stabilised camera, featuring FLIR's thermal imaging technology integrated with DJI's Inspire 1 and Matrice aerial platforms.

Adding thermal imaging to a small UAS platform will bring new capabilities to various commercial applications, including firefighting, search and rescue, wildlife protection, agriculture, and the inspection of bridges, energy infrastructure, and buildings.

Users will be able to view things in complete darkness, see through obscurants such as dust, smoke, and light fog, and measure temperature remotely. Operators will be identify potential problems in buildings, monitor the health of mechanical and electrical equipment remotely, and detect the presence of people or animals.

Andy Teich, president and CEO, FLIR, said: 'FLIR and DJI today support many of the same commercial applications. FLIR is thrilled to work with DJI to deliver these customers a plug-and-play thermal imaging solution for DJI's established ecosystem of unmanned aircraft and related apps while expanding our collective opportunities in the rapidly-growing commercial UAV market.' FLIR Systems teams with DJI Innovations.

<https://www.shephardmedia.com/news/uv-online/flir-systems-collaborates-dji-innovations/>

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### **DARPA is developing miniature laser imaging systems**

The Modular Optical Aperture Building Blocks (MOABB) program aims to develop ultracompact light detection and ranging systems, according to a DARPA news release. LIDAR sends out light and then measures distance by how long the reflected light takes to return. Unlike cameras, which take 2-D images, LIDAR is 3-D. However, the technology is too bulky for widespread use.

Compact LIDAR systems could detect even minor changes of position and speed in nearby objects. Another application, which DARPA is exploring with \$58 million in funding, is detecting objects through foliage. "You would be able to fly a MOABB-enabled helicopter or drone low over a lush forest canopy and be able to effectively peel back the leaves and see a sniper or a tank underneath," said DARPA program manager Joshua Conway. "It could instantaneously give you the range and velocity of everything up to a football field's distance away with the resolution of a camera."

<http://www.c4isrnet.com/story/military-tech/isr/2015/12/15/darpa-developing-mini-lidar/77303718/>

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### **Georgia Tech Research Institute tested unmanned aerial vehicles to operate as a swarm**

GTRI and the Maneuver Center of Excellence have worked together in the past for various academic projects and services, along with agencies such as Defense Advanced Research Projects Agency and U.S. Army Tank Automotive Research, Development and Engineering Center, said Harry Lubin, chief of the experimentation branch at the Maneuver Battle Lab.

The purpose of this UAV research, according to GTRI, is to determine capabilities with large numbers of small UAVs to perform collective operations as a swarm. Research is necessary to acquire swarm behavior algorithms and communication methods that support large numbers of aircraft (1-100), as well as create an operator interface for someone to monitor and direct the swarm. The test consisted of stages in which the initial flight was just one aircraft, followed by three to five aircraft, then 10, and lastly 30 total aircraft flying together.

The MCoE's partnership with this type of research will drive maneuver force innovation and creation, making maneuver leaders and Soldiers smarter, faster, more lethal and very precise in implementing future missions, Lubin explained.

Lubin said UAVs are becoming smarter and will be able to work together to specify a target and get information. A swarm can be applied to make maneuver forces more lethal. The technology will be fast, which is vital as speed is relative to mission success and domination on the battlefield.

"So, we can put unmanned vehicles in areas where it would not be safe to put a manned vehicle, and then we can also have larger numbers of this unmanned vehicles," said Don Davis, principal research engineer, division chief of robotics and autonomous systems at GTRI.

The importance of the swarm is having numerous opportunities to obtain a target, according to Davis. If there are 30 UAVs flying and only one or two make it to the target, it will be able to obtain the information without putting any lives in danger.

What does the future hold for UAV swarm research? The experimenters would like to complete research of this type of maneuver on ground, sea and air. This could eventually lead to unmanned missions, or

assist in missions with Soldiers on the ground, in the water or in the air. The partnership will continue to work with DARPA and other services to improve the development.

"We are trying to make these robots smart so they can work together without having to have consistent human intervention - program them for a mission and then they go out and act on their own," Lubin said.

Lubin, who is in charge of prototype experimentation for the MBL, said the most important factor learned from this research is expanding capabilities of future UAVs.

<http://www.thebayonet.com/2015/12/15/917412/uav-partnership-drives-innovation.html>

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## **COUNTER UAS:**

### **Northrop demonstrates counter UAV technologies**

Systems that can track and eliminate unmanned aerial vehicles are in increasing demand, as the threat of small UAVs that can potentially be outfitted as flying improvised explosive devices grows.

Northrop Grumman recently demonstrated its counter-UAS system, called Venom, for the Army at Fort Sill, Okla., the company said in a release.

The system is capable of tracking small UAVs and providing accurate target coordinates while the UAV is in flight, the company said. Venom is described as a ground based targeting system with Northrop's Lightweight Laser Designator Rangefinder, which can recognize targets in day, night or obscured conditions, range to the target at an eyesafe wavelength, and calculate grid coordinates with the company's GPS/Elevation/Azimuth capability. It operates on a universal stabilized and gimballed mount.

During the demonstration, Venom provided precision target coordinates for fire support receiving "slew-to-cue" messages and locking and tracking low-flying UAVs. Northrop said Venom is "vehicle agnostic," meaning it can be integrated into a wide variety of platforms.

The need to counter small UAVs has prompted a variety of different approaches. The Army, for example, previously repurposed a vehicle mount system for countering rockets, artillery and mortars in order to track and shoot down small UAS. Last summer, the military devoted its Black Dart exercise to testing ways of defending against small drones.

<https://defensesystems.com/articles/2015/12/09/northrop-army-venom-counter-uas.aspx>

[http://www.upi.com/Business\\_News/Security-Industry/2015/12/08/Northrop-Grumman-demonstrates-Venom-targeting-system/9371449590406/](http://www.upi.com/Business_News/Security-Industry/2015/12/08/Northrop-Grumman-demonstrates-Venom-targeting-system/9371449590406/)

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## **Air Defense: Anti UAV Defense**

The number of anti-UAV weapons showing up indicates that the countries with larger defense budgets see a need for this sort of thing and are willing to pay for a solution. That need has been created by the growing availability of small, inexpensive UAVs that can (and are) used by criminals and Islamic terrorists. These more sophisticated AUDs (Anti UAV Defense) are safer (for nearby civilians) to use because they rely on lasers or electronic signals to destroy or disable UAVs. For example the CLWS (Compact Laser Weapon System) is a laser weapon light enough to mount on helicopters or hummers and can destroy small UAVs up to 2,000 meters away while it can disable or destroy the sensors (vidcams) on a UAV up to 7,000 meters away. The CLWS fire control system will automatically track and keep the laser firing on a selected target. It can take up to 15 seconds of laser fire to bring down a UAV or destroy its camera. Another example is an even more portable system that can be carried and operated by one person. This is DroneDefender system, which is a 6.8 kg (15 pound) electronic rifle that can disrupt control signals for a small UAV. Range is only a few hundred meters so DroneDefender would be most useful to police.

There is also a high-end system similar to DroneDefender that can use data from multiple sensors (visual, heat, radar) to detect the small UAVs and then use a focused radio signal jammer to cut the UAV off from its controller and prevent (in most cases) the UAV from completing its mission. The detection range of this AUDS is usually 10 kilometers or more and jamming range varies from a few kilometers to about eight.

AUDS can be defeated. For example a user can send a small UAV off on a pre-programmed mission. This can be to take photos or deliver a small explosive. No one has tried, at least successfully, using armed micro-UAVs yet but North Korea has been caught using small recon UAVs flying under automatic control.

If these UAVs are still detected they have to be destroyed via ground or air-to-air fire. This the South Koreans and Israelis have had to do several times. The Israelis were dealing with Palestinian Islamic terrorist groups using small UAVs, often Iranian models. South Korea and Israel has responded by adding more sensor systems, especially new radars that can detect the smallest UAVs moving at any speed and altitude. The downside of using missiles to machine-guns to take down UAVs is that those bullets and missiles eventually return to earth and often kill or injure people (usually civilians) on the ground.

<http://www.strategypage.com/htm/htada/articles/20151204.aspx>

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### **Drone squad to be launched by Tokyo police**

A drone squad, designed to locate and - if necessary - capture nuisance drones flown by members of the public, is to be launched by police in Tokyo.

The police unit will patrol important buildings such as the prime minister's office.

If a suspicious drone is detected, the operator will be warned via loudspeakers on the ground.

But if he or she fails to respond, police will launch drones equipped with nets to bring down the device.

"Terrorist attacks using drones carrying explosives are a possibility," a senior member of the police department's security bureau told the Asahi Shimbun website.

In April, a drone carrying a small amount of radioactive material landed on the roof of the prime minister's office. No-one was injured and a man was subsequently arrested in connection with the incident.

A video posted online by Japanese website Jijicom shows how Tokyo Police's drones, complete with nets, might catch an unwanted airborne device in action.

#### Airspace restrictions

"In Japan, it is illegal to pilot drones over certain areas such as airports and power plants, over roads, or above a height of 150m," Paul Haswell, a partner at legal firm Pinsent Masons, told the BBC.

"Some cities such as Tokyo and Osaka have also outlawed their use in parks."

Regulations on drones came into force in Japan this week, following an amendment to the country's Aviation Act.

"Japan's new net-carrying, drone-disabling drone is certainly an interesting way to police those areas where drones are forbidden," added Mr Haswell.

Rules over drone use are being tightened up in several countries. In the US for example, authorities have called for a drone register which would list device owners across the nation.

<http://www.bbc.com/news/technology-35070818>

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### **COMMENTARY:**

#### **Despite runaway blimp, lawmakers stand behind troubled missile defense system**

The Pentagon's glitch-prone, \$2.7-billion system of radar-equipped blimps — designed to safeguard the nation's capital against cruise missiles and other airborne threats — has long been a source of frustration to military leaders. A month ago, it became a punch line.

One of the pilotless JLENS blimps broke loose from its mooring in Maryland on Oct. 28 and flew for 150 miles, disrupting civil aviation and damaging power lines with its mooring cable before coming to rest in rural Pennsylvania.

"But they couldn't get rid of it," Huckabee said, "because we had too much money invested in it."

Huckabee's gibe reflected a stubborn truth: the difficulty of killing even deeply flawed defense systems once they have acquired constituencies in Congress and the military.

How a \$2.7 billion blimp system became a 'zombie' program

Congress faces a Dec. 11 deadline to cut \$5 billion from President Obama's proposed military budget, and some programs are at risk. But lawmakers from both parties are standing behind JLENS, despite its well-documented deficiencies.

None voiced opposition to continued funding. Several key lawmakers said through aides that they would not decide the system's fate until the Army has completed its investigation into the cause of the unmooring. Since the inquiry is expected to last months, a decision to await its conclusion is a decision to keep taxpayer money flowing to the program.

After runaway blimp debacle, fresh scrutiny of JLENS missile defense program

JLENS — short for Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System — was intended to protect U.S. troops in combat and American cities and towns by providing early detection of low-flying threats.

For some, JLENS' continued survival defies understanding. In a Nov. 19 essay posted on the website of the nonprofit Project on Government Oversight, former Marine officer Dan Grazier wrote, "It is unclear what, if anything, can actually kill this program."

A senior Democrat on the same two panels, Sen. Barbara A. Mikulski of Maryland, has been one of JLENS' most influential supporters. The operational exercise is based in her state, at the Army's Aberdeen Proving Ground. Maryland is also home to TCOM LP, which makes the blimps and related ground equipment as a subcontractor for Raytheon.

The day after the runaway blimp cut its path through Maryland and rural Pennsylvania, Mikulski sent Defense Secretary Ashton Carter a letter saying she was "deeply concerned" about the episode. She asked military leaders to "determine whether operational testing for JLENS should continue."

Asked where Ruppertsberger stands now on JLENS, aide Jamie Lennon said by email: "We think we need to allow the Pentagon to complete its investigation into the unmooring before any decisions are made regarding the program's future."

Two Californians are among the defense appropriators — Sen. Dianne Feinstein, a Democrat, and Rep. Ken Calvert, a Republican from Corona, in Riverside County.

Feinstein did not respond to requests for comment on JLENS. Through a spokesman, Calvert declined to comment.

Another Californian, Rep. Jackie Speier (D-Hillsborough), has said JLENS "should be the first thing to go" in cutting defense spending. But she does not serve on an appropriations panel.

JLENS has supported hundreds of blue- and white-collar jobs in Southern California, Massachusetts, Maryland, North Carolina, Texas and other states — helping to ensure a wide base of congressional support.

Raytheon, the program's prime contractor, is a reliable source of campaign money. The company is one of the world's largest defense contractors and reported net sales of nearly \$23 billion last year.

From 1999 through September of this year, its political action committee and employees donated a total of \$1.6 million to the campaigns of Congress members now serving on the defense appropriations subcommittees in the House and Senate, federal records show.

Among those 35 members, the top recipient of Raytheon money, with \$107,000 in total donations, was Sen. Jack Reed, a Rhode Island Democrat. In addition to his subcommittee seat, he is the ranking Democrat on the Senate Armed Services Committee.

Ruppersberger's spokeswoman said that "political contributions have no bearing now or ever on the congressman's policy decisions."

A Raytheon spokeswoman said the company would have no comment until the Army had completed its investigation. Yet Raytheon wasted no time in trying to shore up support for the program when the blimp broke free last month.

The 242-foot-long JLENS blimps are designed to operate in pairs, at altitudes up to 10,000 feet. One blimp's radar would search widely for threats. The other's would focus narrowly on airborne objects and transmit "fire control" data on their location, speed and trajectory. U.S. fighter jets or ground-based rockets would use the data to intercept or destroy an intruder deemed threatening.

After years of frustration with JLENS, top Army brass tried to kill the program in late 2010. By then, the Pentagon had spent more than \$2 billion and did not have an operational system to show for it.

As The Times revealed in an investigation published in September, advocates for JLENS, notably Marine Corps Gen. James E. "Hoss" Cartwright, then vice chairman of the Joint Chiefs of Staff, saved the program in 2011 by arranging for the operational exercise — promoted as a way to help protect the nation's capital.

Cartwright retired the same year — and joined Raytheon's board of directors five months later. From 2012 through 2014, Raytheon paid him more than \$828,000 in cash and stock for serving as a director, Securities and Exchange Commission records show.

Last spring, JLENS suffered a major embarrassment when a postal worker flew a small rotary-wing aircraft through Washington's highly restricted airspace as a political protest, landing on the West Lawn of the U.S. Capitol.

The single-seat craft was just the kind of tree-skimming intruder JLENS was designed to detect. Yet the system was not working; software problems with the "fire control" radar had grounded one of the blimps.

It was against that backdrop that a JLENS blimp broke loose Oct. 28, dragging its 6,700-foot Kevlar mooring cable behind it. The cable knocked out electricity to 35,000 Pennsylvania residents. F-16 fighter-jets were scrambled to track the blimp.

It came to rest in high trees in Moreland Township, Pa. The next day, at the military's request, six state troopers with shotguns unleashed "a barrage" at the tattered blimp to drain its remaining helium, said State Police Capt. David Young.

"No one had ever seen anything like this," said Frederick Hunsinger, public safety director for Columbia County, Pa., recalling the hundreds of phone calls his department fielded after the renegade blimp appeared in the sky. "It just kind of descended on us."

<http://www.latimes.com/nation/la-na-blimps-funding-20151130-story.html>

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### **Can Surveillance Drones Prevent The Next Kunduz?**

AFSOC commander describes how a jerry-rigged antenna contributed to the tragedy – and what solutions are already in the pipeline.

A Ku-band antenna that had been "scabbed" onto an AC-130U gunship failed to transmit video on the morning of Oct. 3 during a mission in Kunduz, Afghanistan, contributing to a tragedy in which more than 30 people died, Air Force Special Operations Command Gen. Bradley Heithold said today.

Malfunctioning gear had already been fingered by Gen. John Campbell, who issued a Nov. 25 statement on the airstrike that destroyed a Doctors Without Borders hospital. "During the flight, the electronic systems onboard the aircraft malfunctioned, preventing the operation of an essential command and control capability and eliminating the ability of the aircraft to transmit video, send/receive email, or send/receive electronic messages," the report reads, in part. "Confusion was exacerbated by the lack of video and electronic communications between the headquarters and the aircraft, caused by the earlier malfunction," it continues.

Today, for the first time, Heithold went into more detail on what exactly went wrong on the AC-130.

"Today, we pump full-motion video into the airplane and out of the airplane. So we have a Ku-band antenna on the airplane ... the U-model. It's sort of scabbed on. In fact, we had some problems with it recently on a mission in Afghanistan where it didn't work. I wish it had been working," Heithold said.

"On our current legacy airplanes, the solution we used was rather scabbed on: take the overhead escape hatch out, put an antenna on, stick it back up there, move the beams around. We've had some issues, but we're working with our industry partners to resolve that issue."

He added, “99.9 percent of the time we’ve had success with it. These things aren’t perfect; they’re machines.”

Heithold said that dedicated Ku-band data transfer is now standard on later models of the AC-130, which should make data transfer much more reliable. “If you’re looking at an AC-130J, for instance, you’ll see a bump in the area just above the co-pilot. That is a built-in Ku-band capability to move information into and out of the airplane, primarily full-motion video ... The AC-130W? It’s built in. The AC-130J? It’s built in. It’s going to be much more reliable than the case of our legacy airplanes,” in Kunduz, he said.

The technological problems Campbell describes in his report stand in stark contrast to the way information and data processing are supposed to work on an AC-130. Ideally, in a situation like the one that played out on Kunduz, its crew can see and transmit full-motion video data from the plane’s battle management center computer, or BMC. When the BMC is working properly, the Joint Operations Center, or JOC, is able to see what the gunship is targeting via the video-feed. Combat air controllers or soldiers on the ground can also see what’s happening via small, handheld tablet computer called a Remote Operations Video Enhanced Receiver or ROVER.

Some AC-130 also carry a targeting laser, sometimes referred to as a “Big Ass Green Laser” but which Heithold called simply the “green beam.” It allows ground crew to co-ordinate targeting decisions.

The green beam “can point at the target and [allow operators to] say, ‘Yup, you’re looking at the right thing,’” said Heithold. But it only works when ground troops have “eyes on the target” – which the Campbell report makes clear was not the case. And Heithold, a lack of eyes is no longer an exceptional situation. It’s becoming the norm.

“The fights that we’re in today, the JTAC is frankly not on the objective. They’re in the rear making the call based on what we’re showing them,” he said.

#### Drones To Fill In Intelligence Gaps

Effort to extend the aircrew’s awareness go beyond the aircraft itself, Heithold said. Under an initiative dubbed, Tactical Off-Board Sensing, the AC-130 might launch small foldable drones – Heithold mentioned Raytheon’s Coyotes – to provide full motion video.

“It comes out of that tube. It goes in a pre-planned orbit. I can stand off somewhere. It can tell me what’s there. It gives me a site picture before I ever get there. Now I can strike from a distance,” he said.

The Air Force has tested the system and will soon try it out in combat, said Heithold. The tragedy in Kunduz created a special urgency for the new capability.

“In a case like that, had you had another set of eyeballs – it’s another sensor on the airplane. We’ve got two very-high-definition sensors on the AC-130. Imagine now if I can duplicate that by taking something off the airplane, getting it down [closer to the target.] It’s quiet. It’s got a pretty darn high-definition sensor ... I get a heck of a lot more fidelity on the target back to the airplane ... giving the airplane

visibility on the target up close. More visibility and clarity I have on the target, the more effective I'm going to be," he said.

"Sometimes it's old-style Vietnam," he said. "Make contact with the guy on the radio and talk on the target. And we have to train our crews that when technology fails us, we're still able to prosecute the mission by talking the way we used to, 'what are you looking at?' Well, I'm looking at this." So technology is going to help us in many, many ways but we also want our crews to know, it won't always work ... That stuff fails, you've got to be able to go back to the dead reckoning. Same situation here. If it fails, you're not going to have the level of fidelity on the target, etc. as you had had it been working. It's common sense."

<http://www.defenseone.com/technology/2015/12/can-surveillance-drones-prevent-next-kunduz/124178/>

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### **Contracting With and Between UAS Operators**

The Unmanned Aircraft System (UAS) industry is evolving at a speed that is hard to keep up with, even for those intimately involved with it. It has been said that a "drone year" is the equivalent of one calendar month; such is the pace of change. New aircraft technology is influencing all areas of the UAS industry—from manufacturing techniques and materials to flight controllers and apps. Professional operators of drones face a vast array in choice of platform (aircraft) for their given role.

White Paper/article download available at the below link:

<http://www.dentons.com/en/insights/guides-reports-and-whitepapers/2015/december/4/contracting-with-and-between-uas-operators>

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### **Don't Forget COIN, Because COIN Threat's Getting Worse: CNAS**

WASHINGTON: As the US military refocuses on Russia and China, it mustn't forget the hard-won lessons of Afghanistan and Iraq, because they'll only become more relevant in future conflicts. With technology spreading, populations rising, and megacities sprawling, "war among the people" — whether it's counterinsurgency, counter-terrorism, or just conventional warfare in an urban setting — will only get nastier and harder to avoid.

You thought roadside bombs were bad? Imagine off-the-shelf mini-drones bombing US troops. Home-brewed high explosives got you down? Imagine extremists with 3D printers and a database of weapon designs. Suicide car bombs? Imagine explosive-laden cars that drive themselves. US military transmissions jamming each other by accident? Imagine guerrillas getting cheap GPS and radio jammers online. Media revealing military secrets or reporting faux pas that get the local population up in arms? Imagine that local population, enemy informants included, tweeting video of everything US forces do.

“The problem of war among the people is getting harder,” said Paul Scharre, a former Army Ranger and civil affairs officer. “It’s getting more lethal, and people are empowered by information technology: They’re able to communicate and organize for action in ways they weren’t ten years ago. All of that makes war on the ground much more challenging.”

“In many ways,” Scharre told me, “the root of intellectual stagnation here in US defense circles comes from watching too many World War II movies.” In those films, there’s a clear start to the war, clearly uniformed combatants (except for the occasional partisan), and a clear happy ending. Historically, he said, “that’s the exception rather than the rule.”

Scharre is an Iraq and Afghanistan veteran who heads the 20YY Future of Warfare Initiative at the Center for a New American Security. He’s also one of my favorite futurists, and I’ve interviewed him many times on topics from the ethics of armed robots to keeping combat operations secret in the age of YouTube and Twitter. The report out today, *Uncertain Ground: Emerging Challenges in Land Warfare*, pulls together all that work and more to present a distinctly unsettling picture of future land combat.

“Similarly, ad hoc networks of like-minded individuals could swarm military forces, disrupting their movements via digitally-empowered ‘smart mobs’ on landing zones or roads. Unarmed mobs could incite military forces to respond, all the while filming their actions for broadcast. Militaries will be hard pressed to hide their movements in a world of radical transparency, and greater connectivity will enable enemies to rapidly organize to attack U.S. forces.”

Not all the new technologies that concern Scharre are commercially available off the shelf, but even strictly military tech is proliferating beyond the hands of states. Precision firearms, for example have remained experimental even for the US Army — the XM-25 smart grenade launcher was never fully fielded — but cheaper aim-correcting technologies now in development could make every untrained insurgent a marksman.

Already, anti-tank and anti-aircraft missiles are widely available across the Middle East, Scharre notes, and “over 90 countries and non-state groups already have drones, and 30 countries have or are developing armed variants.” While America’s stealth-fighter fleet may dominate at high altitudes, he writes, low-flying swarms of expendable drones may bring US ground troops under enemy air attack for the first time since 1953.

As a result, “even in a conflict against a nation-state, enemies will still be able to employ significant lethality after the U.S. military has destroyed major military combat capabilities,” Scharre writes. “After seizing ground and destroying the enemy’s major military units, U.S. forces cannot simply [declare victory]. The unfortunate reality is that, in many conflicts, seizing ground may be the equivalent of merely grabbing hold of the hornet’s nest.”

“This democratization of information dramatically changes the social landscape in which conflict occurs,” Scharre writes. That means we’d better understand that changing landscape before we send troops into it. “Training in kinetic operations cannot neglect the parallel fight for the human terrain...bullets do not fire on their own. Tanks and bombs are merely tools; wars are fought by people.”



<http://breakingdefense.com/2015/12/dont-forget-coin-because-coin-threats-getting-worse-cnas/>

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## **Autonomous Drones May Be on the Horizon**

We are not that far off from a day when one autonomous weapons system – read robot or drone – takes on another autonomous weapons system.

That's the take of Skip Parish, a Sarasota inventor and unmanned systems innovator who just returned from a NATO conference in Berlin where he spoke about such issues.

I last talked with Parish just before he headed out to Berlin for NATO's Concept Development and Experimentation Conference, which took place last month in Berlin.

The conference, according to NATO, is the organization's "leading annual forum" to talk about future developments.

Those senior officers, he said, came to hear about how to counter enemy drones and robots and whether to use autonomous weapons or not. And in what circumstances.

A lot of the conversation was essentially about how to turn off enemy drones using electronic warfare systems before the enemy turns off yours.

"You'd have to say offensive electronic warfare rather than defensive," he said.

The next logical step, he said, was if you weaponize such systems, "whether you should let them loose on their own, or have the man in the loop."

Current unmanned aerial systems, like Predators or Reapers, have a pilot and a sensor operator who remotely operate the aircraft and fire the weapons.

Repeating what he told me the last time we talked, Parish said that may not be ideal in systems of the future because if an enemy drone operates on algorithms, it will blow a human-piloted system out of the air before it can react.

The question, at this point, is who will be first with drones on their own.

And when.

The time is not far off, he says.

The Pentagon has already laid down the ground rules on how and when to use autonomous systems.

Called "Directive 3000.9" it established Defense Department policy and assigned responsibility for the use of autonomous and semi-autonomous functions in weapons systems, including manned and unmanned platforms.

Think Terminator.

Since late 2002, Canning has been working on the autonomous use of weapons by robotic systems.

"To the surprise of most, not only have I figured out how to have robots figure out for themselves when to pull the trigger, but how to do this while keeping the lawyers happy," he said in an email.

The non-governmental organization says "allowing life or death decisions to be made by machines crosses a fundamental moral line. Autonomous robots would lack human judgment and the ability to understand context. These qualities are necessary to make complex ethical choices on a dynamic battlefield, to distinguish adequately between soldiers and civilians, and to evaluate the proportionality of an attack."

The use of fully autonomous weapons "would create an accountability gap as there is no clarity on who would be legally responsible for a robot's actions: the commander, programmer, manufacturer, or robot itself? Without accountability, these parties would have less incentive to ensure robots did not endanger civilians and victims would be left unsatisfied that someone was punished for the harm they experienced."

"My issue is that they assume from the beginning – even with their name – that we will be designing machines to autonomously target and kill people," he said. "Nothing could be further from the truth! We need to have the other side of the issue told so that the rest of the world can see the fallacy of the "'Stop Killer Robots' campaign."

"The ultimate goal in warfare is not to kill the enemy, but to bring hostilities to a complete and lasting close as quickly, and as humanely, as possible," said Canning, quoting Department of Defense attorney Col. W. Hays Parks, 12 years ago at a meeting at Dahlgren.

Current technology – including existing drones and even manned aircraft (think the killing of 30 at the Doctors Without Borders hospital in Afghanistan by a U.S. AC-130 gunship) – is far from fallible. So there's a lot to consider.

There are two main types of systems covered by the directive.

Autonomous weapons systems are those that, once activated, "can select and engage targets without further intervention by a human operator. This includes human-supervised autonomous weapon systems that are designed to allow human operators to override operation of the weapon system, but can select and engage targets without further human input after activation."

Semi-autonomous weapons systems are those that, once activated, are intended to only "engage individual targets or specific target groups that have been selected by a human operator."

The Pentagon directive is explicit in the role of these systems.

“Human-supervised autonomous weapon systems may be used to select and engage targets, with the exception of selecting humans as targets, for local defense to intercept attempted time-critical or saturation attacks.”

Furthermore, the directive holds that “autonomous weapon systems may be used to apply non-lethal, non-kinetic force, such as some forms of electronic attack, against materiel targets.”

Semi-autonomous weapons systems, meanwhile, “may be used to apply lethal or non-lethal, kinetic or non-kinetic force,” according to the directive.

Such systems onboard or integrated with unmanned platforms “must be designed such that, in the event of degraded or lost communications, the system does not autonomously select and engage individual targets or specific target groups that have not been previously selected by an authorized human operator.”

“The scope of our approach is broader,” he says. “We go to pains to try to separate an enemy combatant from his weapon before going after his weapon. We have taken great care in addressing the Law of War’s Principles of Distinction, Proportionality, and Precautions.”

For instance, by using “directed energy” weapons, U.S. troops can disarm an enemy without necessarily killing, Canning says.

“We think, however, that we have a better shot at reducing collateral damage because our machines will never autonomously target people, and can use non-traditional weapons,” Canning says. “We will, however, retain the ability to roll a human operator into the control loop so that he may make a targeting decision on a person, if he needs to. Thus, a human will have control under those circumstances, and will also set the parameters that will be used by our autonomous machines when they target the other guy’s hardware.”

<http://www.tbo.com/list/military-news/altman/autonomous-drones-may-be-on-the-horizon-20151213/>

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## **These are the Decisions the Pentagon Wants to Leave to Robots**

The U.S. military believes its battlefield edge will increasingly depend on automation and artificial intelligence.

It’s a “wonderful time” to be a military scientist, where the next big leaps will depend on rapid advances in machine learning, artificial intelligence, and computer science – but the Pentagon needs to catch up to private industry, says deputy defense secretary Robert Work.

Yet the development of new artificial intelligence and autonomy capabilities is key to the Pentagon's third offset strategy, a research effort intended to endow the United States with strategic advantage over her adversaries. In his talk, Work cleared up several of the mysteries surrounding the third offset strategy, including: Just what does the military want robots to take over for humans? Here are a few areas Work highlighted.

Cuing intelligence analysts about what to pay attention to

Machine learning systems looking through volumes of data to find weak signals of social change could provide early indicators of danger or unrest, deserving analyst attention. "The AI guys say that what's happening in the grey zone with the little green men is nothing more than a big data analytics problem," Work said. He spoke of a National Geospatial Intelligence program called Coherence Out of Chaos, which could "cue human analysts" to take a look at different situations as those situations evolve on the ground. "It will do so in situations that require faster than human reaction," he said.

Conducting cyber defensive operations, electronic warfare, and over-the-horizon targeting

"You cannot have a human operator operating at human speed fighting back at determined cyber tech," Work said. "You are going to need have a learning machine that does that." He did not say whether the Pentagon is pursuing the autonomous or automatic deployment of offensive cyber capabilities, a controversial idea to be sure. He also highlighted a number of ways that artificial intelligence could help identify new waveforms to improve electronic warfare.

...and how to fly and land

Assisted human operations is another key component of the AI-heavy offset strategy. Work cited the Aircrew Labor In-Cockpit Automation System, or ALIAS, which takes some of the decision-making away from the pilot. It was, he said, "A system designed to reduce the number of crew in the cockpit at any time."

Flying drones and driving boats

Work defined human-machine combat teaming as a human working with an unmanned aerial vehicle, or UAV, to conduct operations. "The Army's Apache and Gray Eagle UAV are designed to operate together. The P-8 [Poseidon] and [MQ-4C] Triton UAV work together," he noted. "We are looking at a large number of very, very advanced things." He cited recent programs that would deploy cascades of small drones from larger drone "motherships," (a DARPA program called Gremlins), swarming boats (an Office of Naval Research program), and efforts to allow a single human operator to direct a wide number of drones (as opposed to several crewmembers operating one drone, which is the state today, part of an Air Force effort called the Vigilant Spirit Control Station).

Many of these AI aids and capabilities would be backed by a fast-learning system that collects, processes, and disseminates information to help commanders make better decisions. He described it as a "learning network." It would not replace humans but vastly accelerate the collection and dissemination of relevant data and commands to more machines and humans on the battlefield.

There's "a lot of skepticism right now inside the department of defense that we will be able to perfect and protect such a network," Work said. "But if you do the smart design up front, coupled with learning defenses. It is not only possible but it is a requirement."

<http://www.defenseone.com/technology/2015/12/these-are-decisions-pentagon-wants-leave-robots/124480/>

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## **Droids and The Force: How the Science in 'Star Wars' is Actually Real**

(SPEAKEASY (WALL STREET JOURNAL) 14 DEC 15) ... P.W. Singer and August Cole

For a story that takes place "a long time ago in a galaxy far, far away" a great deal of the technology in the "Star Wars" series actually has parallels today on planet Earth. Part of the reason is, ironically, how long the franchise has been around. Concepts and ideas that were the stuff of science fiction when the first "Star Wars" movie came out in 1977 have had almost four decades of science to become real.

Here's a look at a few of the technologies and scenes that you can tell fellow moviegoers are actually the real deal:

### **Lasers and Energy Weapons**

"Hokey religions and ancient weapons are no match for a good blaster at your side, kid." Han Solo warned Luke Skywalker when they met in "Star Wars: A New Hope," and some 30 years later in "The Force Awakens" he's still packing the same blaster he shot first with. But while Ronald Reagan was inspired back then to try to build his own version of what became known as "Star Wars" weapons to fend off the Soviets, such energy weapons like blasters and laser cannons were pure science fiction. Today, though, the U.S. Navy has deployed lasers aboard warships like the USS Ponce in the Persian Gulf to defend against drones and small boats, while testing is under way for more powerful truck-mounted and airplane-mounted lasers. Similarly, the electromagnetic rail gun that was one of the many defenses of the first Death Star will be tested for deployment onto U.S. warships like the USS Zumwalt (the star, in turn, of our book "Ghost Fleet"), while China is working on its own version.

### **Droids**

The new movie will feature a range of new robots, like the cute BB-8 as well as old friends like R2-D2. While they may not chirp and burble in the real world, real robots have already become a staple of the modern battlefield. Thousands of all shapes and size already serve in the U.S. military, from the MQ-9 Reaper in the air or the Packbot on the ground. And, if the U.S. Air Force's strategic plan for the future comes true, they soon will be flying as wingmen alongside manned fighters; imagine if droids didn't ride in the back of the X-wing fighter but flew on their own.

### **Space Battles**

Fighting it out in the vacuum of space is a staple of science fiction, but is also becoming a key part of war plans. Unlike back in 1977, space is now the nervous system of the modern military. Over 1100 communication satellites link planes, missiles and troops in the field (80% of overall communications the U.S. military sends goes through satellites), look down to spy on every movement on land, air and sea, and run navigation networks such as GPS that are used not just to guide trucks and tanks (and your car), but also to place missiles on targets with an accuracy of centimeters. As a result, the U.S., China and Russia are all at work on space weaponry of some sort to take this advantage away from their foes, ranging from U.S. and Chinese tests of anti-satellite missiles (notably, the test shot of one missile was described as causing “an explosion worthy of the ‘Star Wars’ franchise”) to Russian work on killer kamikaze-style satellites. Or, the space systems could mount weapons themselves. In another example of science fiction crossing with science reality, astronomers at UC Irvine are exploring the mounting of a laser on the International Space Station in 2017, in order to destroy any threatening space debris ... or attacking TIE fighters.

Mind Control and The Force: It wasn’t just starships that could move objects from afar, but also the Jedi, in their case by thought alone. Even more, they could manipulate other peoples’ thoughts. While the U.S. military does have a team of strategists at the School of Advanced Military Studies known as the Jedi, the real-world parallel is more through technology, not mythical “midichlorians.” Brain-machine interfaces, such as the Braingate project, turn your thoughts into digital signals that can go out to control machines, such as a bionic hand (Luke’s artificial hand actually looks a bit dated compared to the real world DEKA, a bionic, mind-controlled hand approved by the FDA last year). In turn, projects such as DARPA’s Systems-Based Neurotechnology for Emerging Therapies, or SUBNETs, program are designed to send signals back into the brain, reshaping thoughts and memories. They initially designed for treatment of maladies that range from Parkinson’s disease to PTSD.

What Isn’t There

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